Imperial College London

Higgs Searches at the Tevatron

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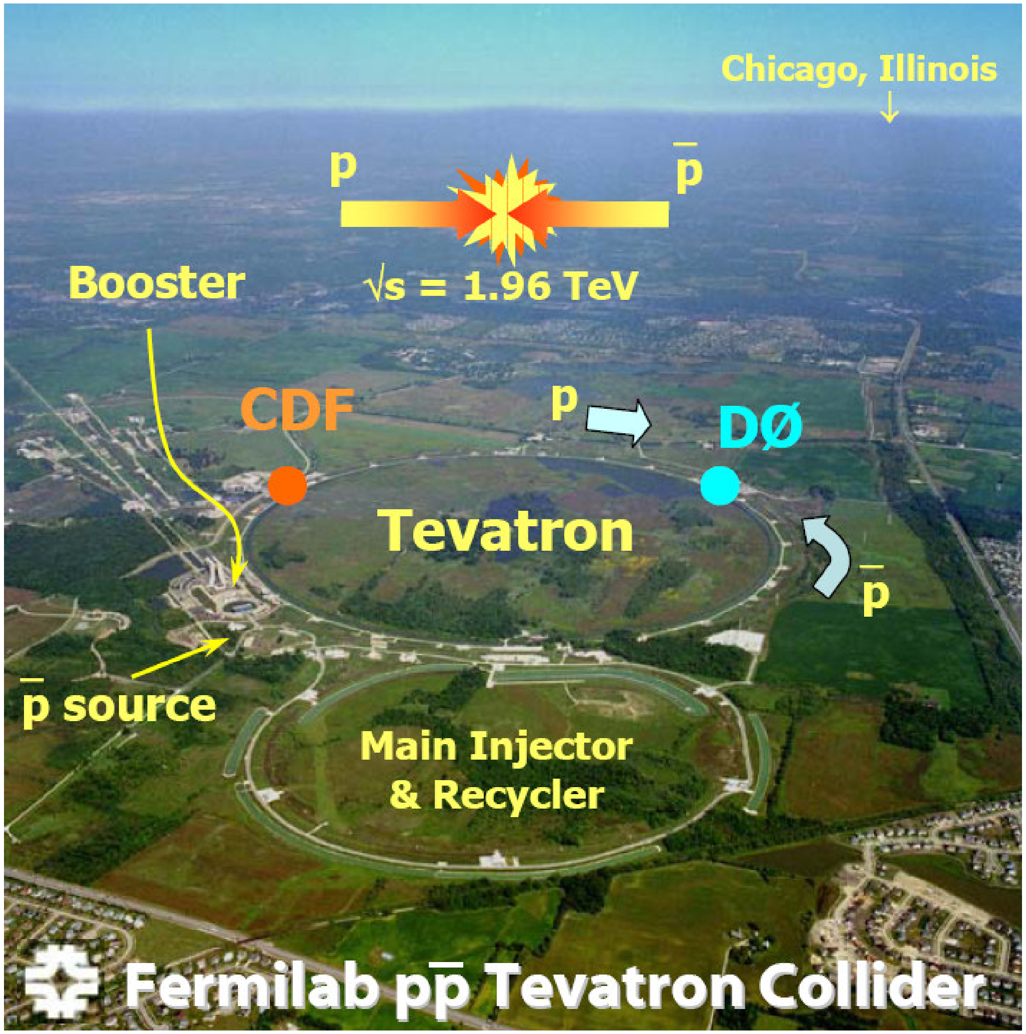
On behalf of the CDF and DØ Collaborations

Outline

- Introduction
  - Tevatron & experiments
- Standard Model (SM) Higgs
  - Introduction
  - Results
    - Low & high mass
    - Combination
- Non-SM Higgs
  - Minimal Supersymmetric SM
- Prospects & Conclusions

Results shown use ~1fb^{-1}

(2fb^{-1} this summer)

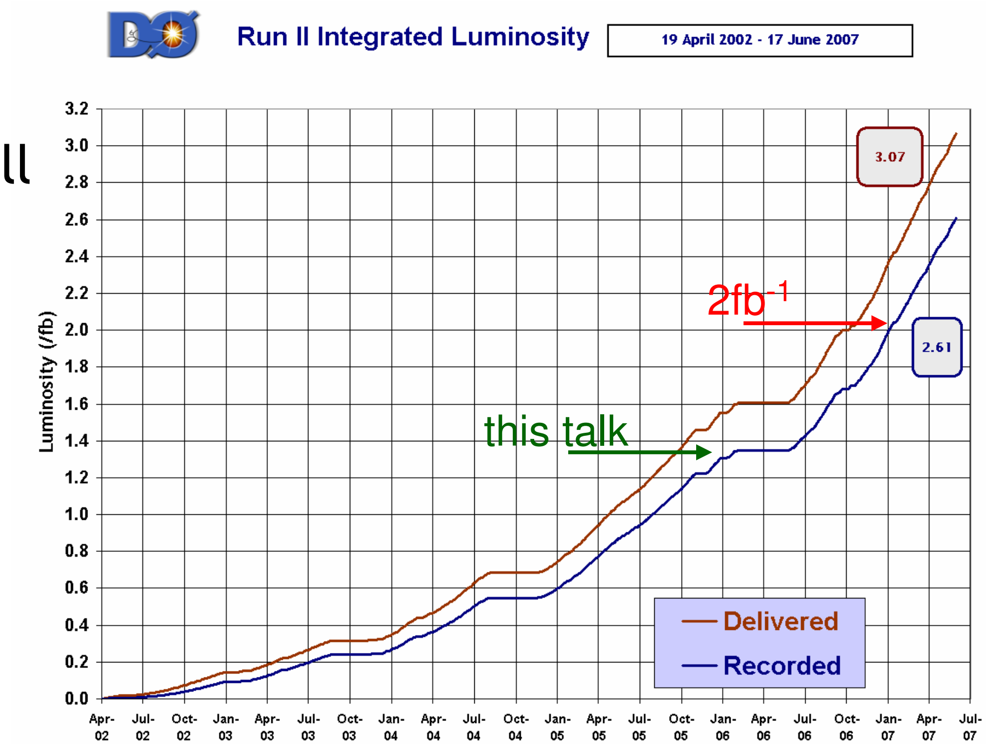


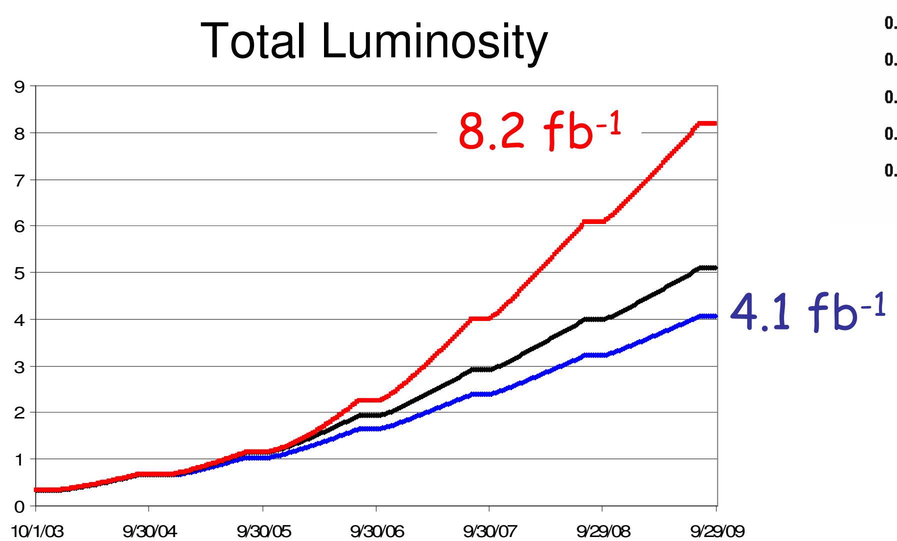
[Thanks to all my Tevatron colleagues]

Tevatron Performance

Tevatron continues to perform well

- Over $3 fb^{-1}$ delivered to each experiment
- Peak luminosities of ~3×10^{32}

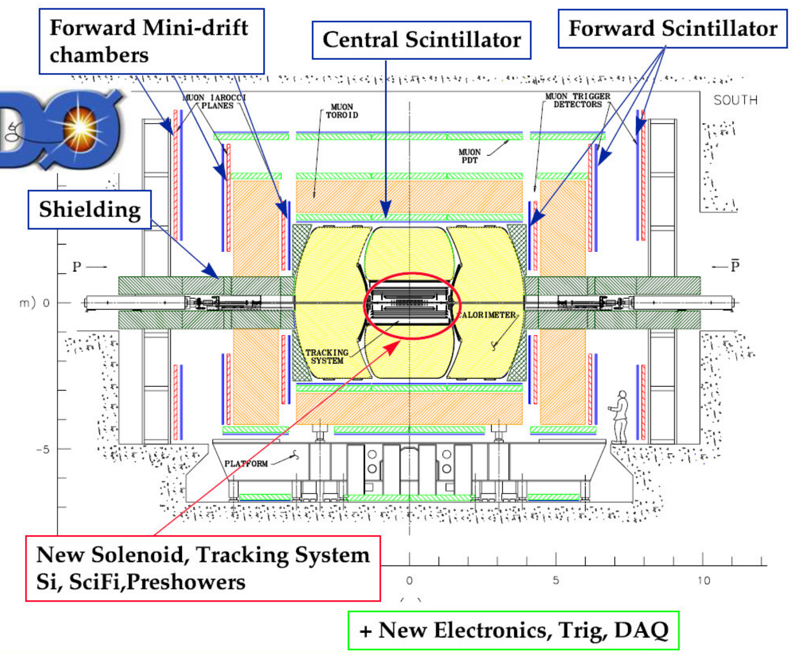


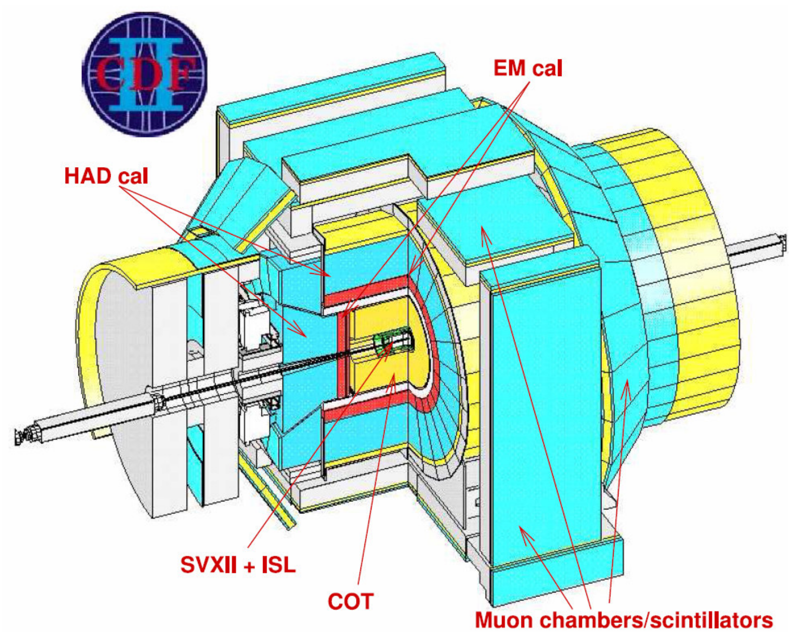


- Performance matching design integrated luminosity of ~$8 fb^{-1}$ by 2009

CDF and DØ experiments

- Both detectors extensively upgraded for Run IIa
  - New silicon vertex detector
  - New tracking system
  - Upgraded muon chambers





- DØ
  - New solenoid & preshowers
  - Run IIb: New inner layer in SMT & L1 trigger

- CDF: New plug calorimeter & ToF

Standard Model Higgs

- Introduction
  - Constraints on the Higgs
  - Higgs Production at Tevatron
  - Techniques / status

- Low mass
  - $WH \rightarrow l\nu b\bar{b}$
  - $ZH \rightarrow llb\bar{b}$
  - $ZH \rightarrow \nu\nu b\bar{b}$

- High mass
  - $H \rightarrow WW$

- Combination

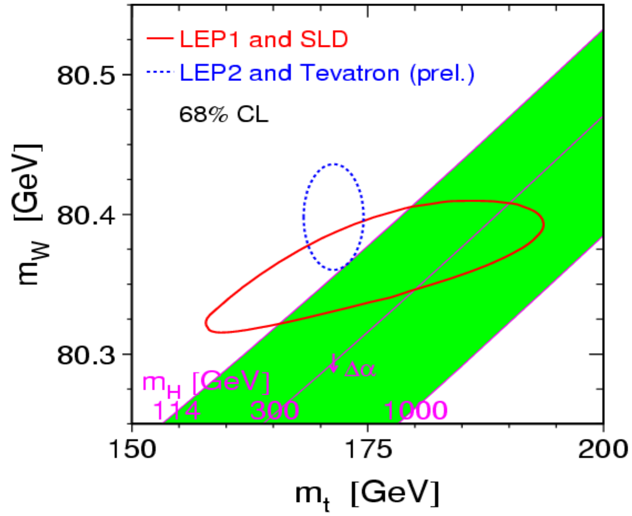
Standard Model Higgs

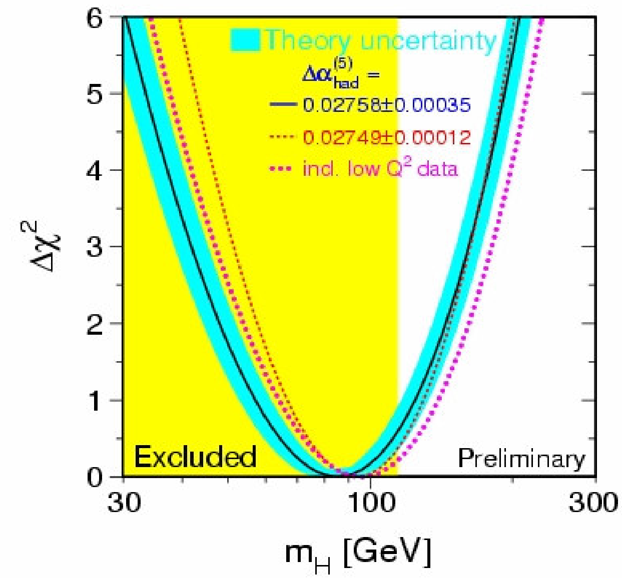
- Higgs mechanism
  - Additional scalar field in SM Lagrangian
    $\rightarrow$ mass to W,Z & leptons
  - Predicts neutral, spin 0 boson
    - But not its mass

- Direct searches at LEP2
  - $m_H > 114.4$ GeV @95%CL

- Improved m_t & m_w tighten indirect constraints:
  - $m_H < 144$ GeV @ 95%CL (EW fit)
  - $m_H < 182$ GeV if LEP2 limit included

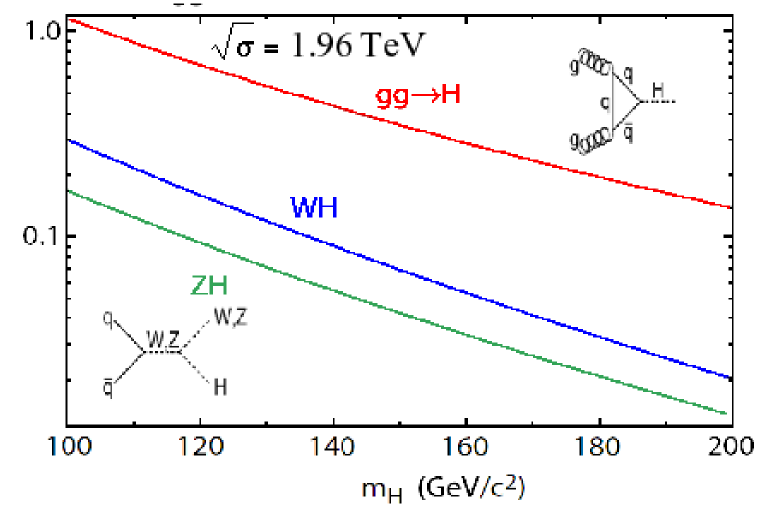
$\rightarrow$ A light Higgs is favoured

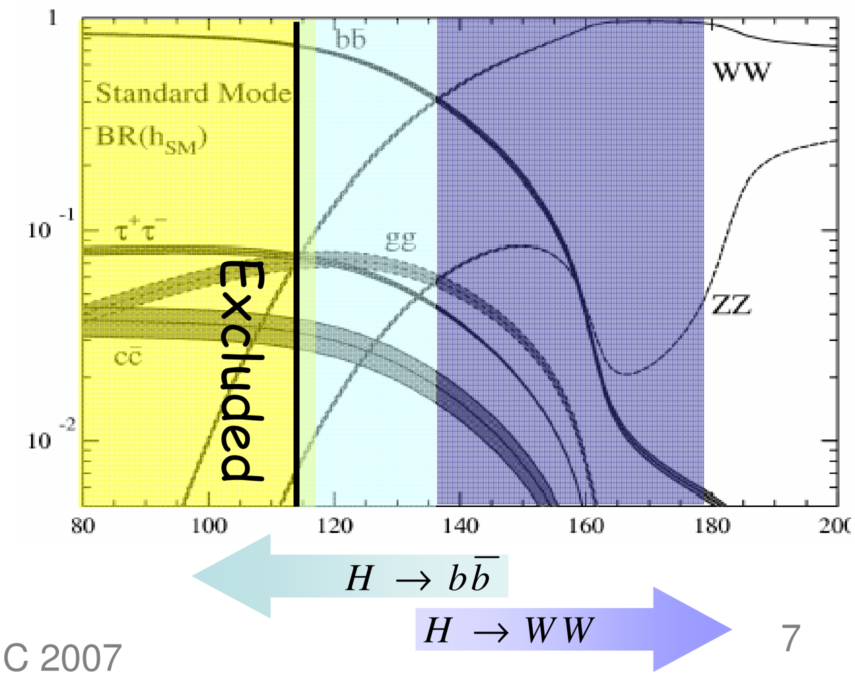




SM Higgs Production & Decay

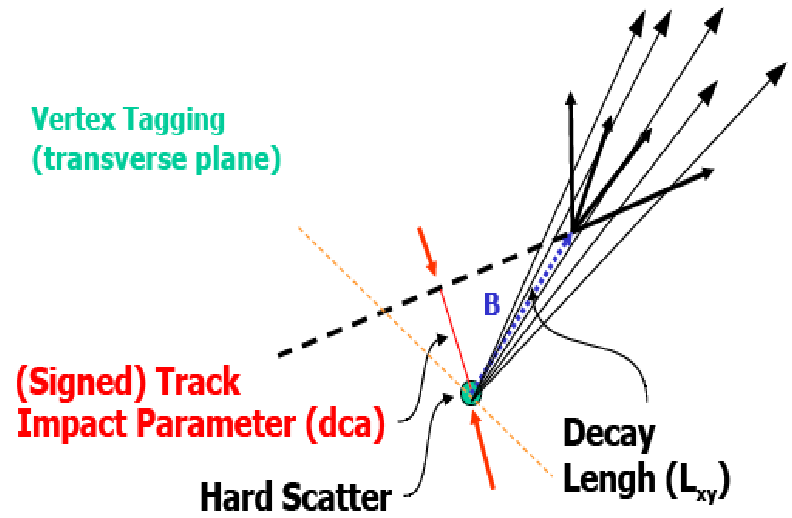
- Small production cross-sections
  - 0.1 -1 pb cf WZ, ZZ, single top @~2-4pb
- Branching ratio dictates search
- m_H < 135 GeV
  - gg → H → bb overwhelmed by multijet (QCD) background
  - Associated WH & ZH production with H → bb decay
  - Main backgrounds: Wbb, Zbb, W/Z jj, top, di-boson, QCD
- m_H > 135 GeV
  - gg → H → WW
  - Main background: WW





B-tagging

- Critical for low mass H→ bb
  - Improves S/B by > 10
- Use lifetime information
  - Correct for MC / data differences
    - Measured at given operating points



CDF: Secondary vertex reconstruction

- Neural Net - improves purity
- Inputs: track multiplicity, p_T, vertex decay length, mass, fit

- **Loose = 50% eff, 1.5 % mistag**
- **Tight = 40% eff, 0.5 % mistag**

DØ: Neural Net tagger

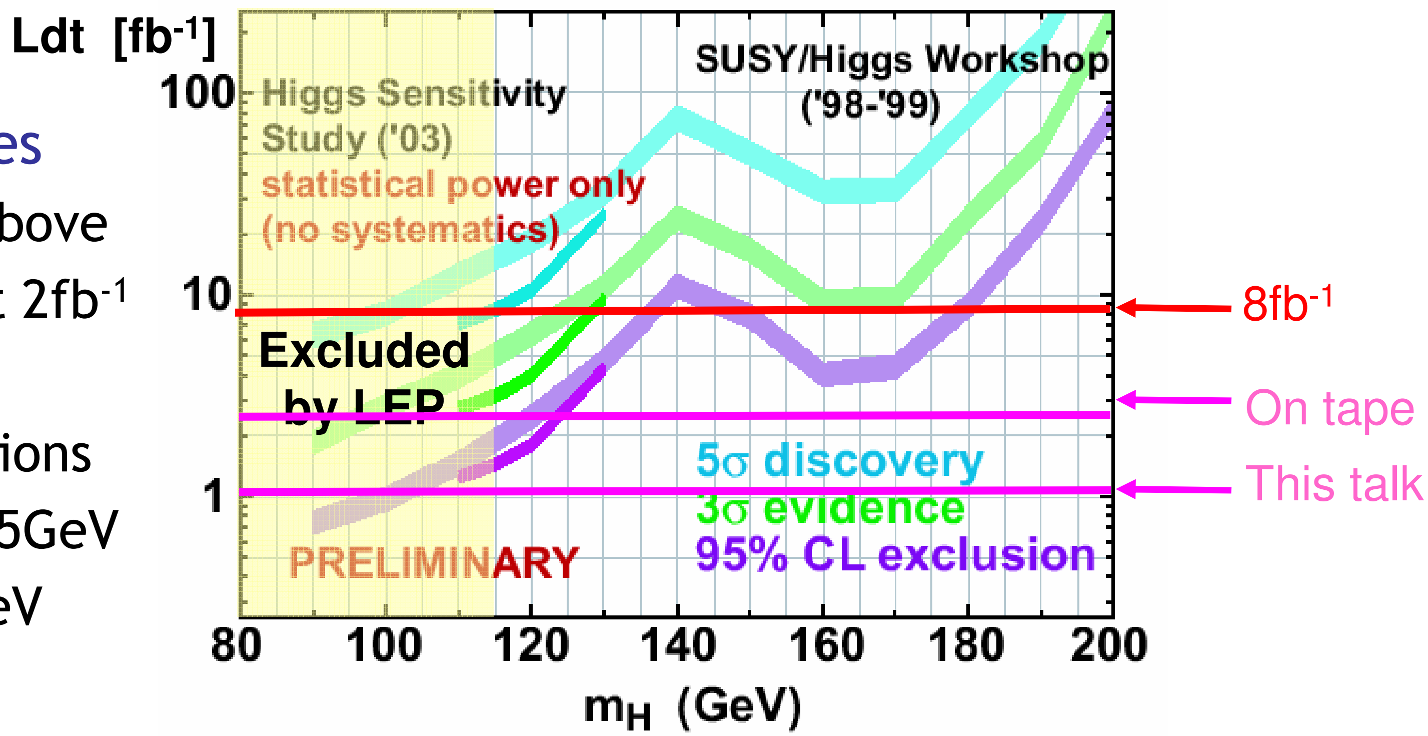
- Secondary vertex & dca based inputs, derived from basic taggers
- High efficiency, purity

- **Loose = 70% eff, 4.5% mistag**
- **Tight = 50% eff, 0.3% mistag**

- Analyse separately ("tight") single & ("loose") double tags

Higgs Sensitivity

- Previous studies
  - Sensitivity above LEP starts at $2fb^{-1}$
  - $8fb^{-1}$: Exclusions from 115-135GeV & 145-180GeV



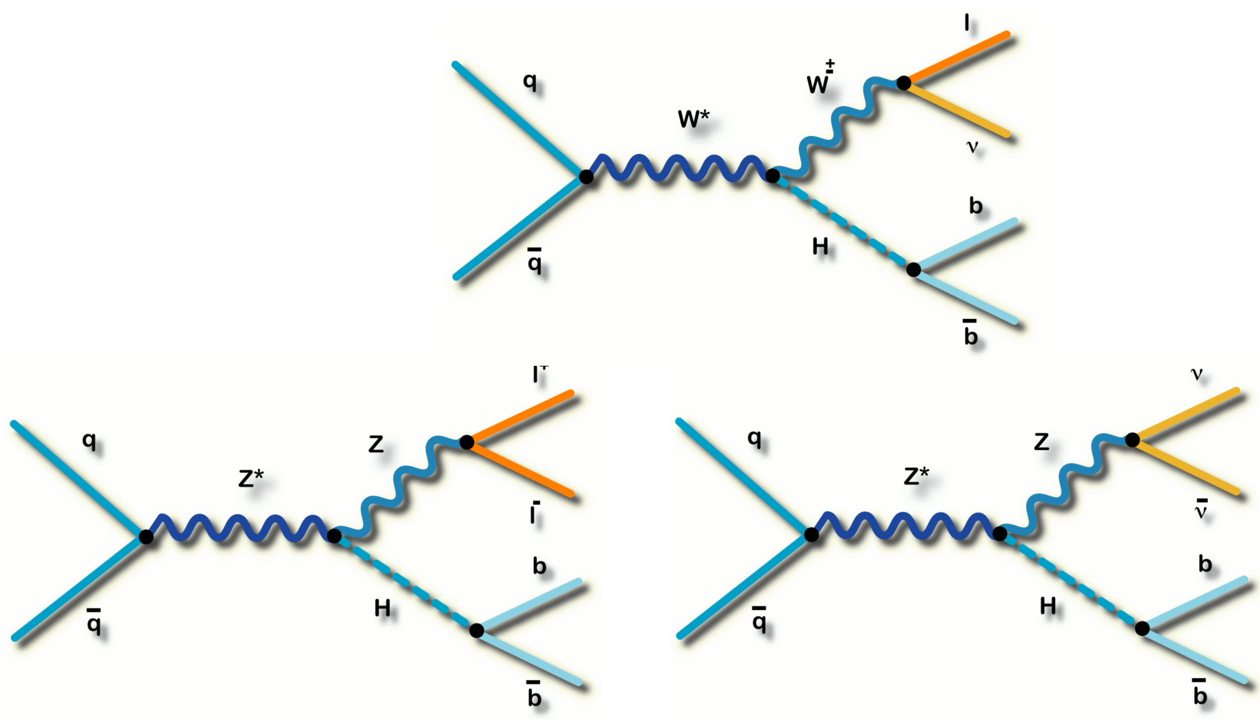
- Now:
  - Measuring SM backgrounds (tt, Zbb, Wbb, WZ, ZZ, single top !)
  - Optimizing analysis techniques
  - 1st combined Higgs limits & comparing to predictions

Low mass SM Higgs

- Introduction
- Low mass
  - $\boxed{WH \to l\nu b\bar{b}}$
  - $\boxed{ZH \to llb\bar{b}}$
  - $\boxed{ZH \to \nu\nu b\bar{b}}$
- High mass
- Combination

Leptonic decay of W / Z boson provides 'handle' for event

H $\rightarrow$ bb helps reduce SM background



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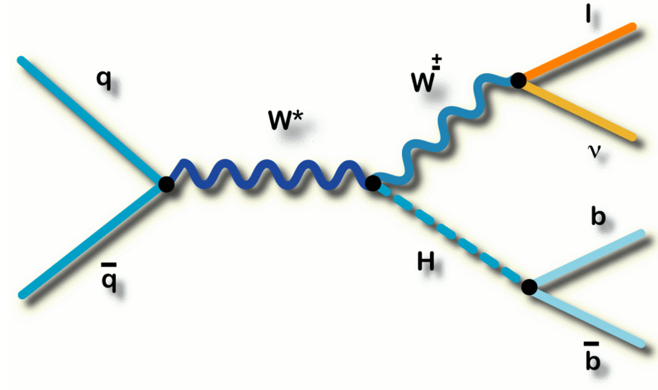
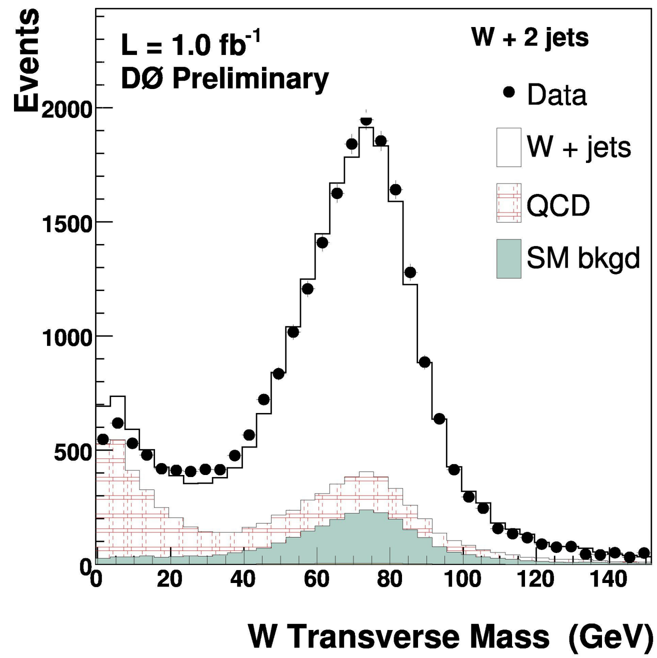
$WH \to l\nu b\bar{b},\ l = e, \mu$

- Highest cross-section
  - Use electron and muon channels
- Selection
  - Isolated lepton, p_T > 20GeV
  - Missing E_T > 20GeV
  - Two jets:
    - p_T > 15GeV (CDF)
    - p_T > 20GeV (DØ)
- Backgrounds
  - W+jets, QCD, top, di-boson
- Analyses
  - CDF & DØ: Cuts based analyses
  - DØ also has a Matrix Element analysis



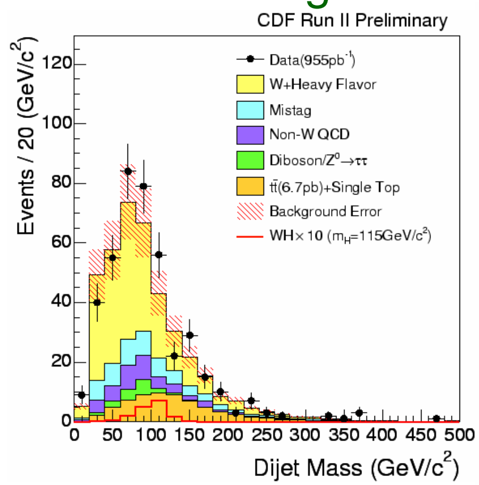


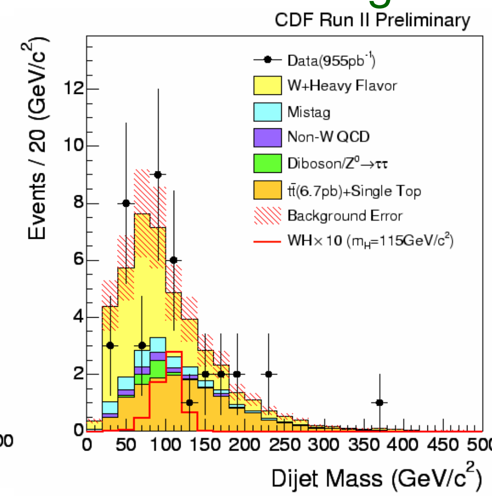
$WH \to l\nu b\bar{b},\ l = e, \mu$

- Separate 1 “tight” & 2 “loose” b-tag channels
- No significant excess
- Cross section limits derived from invariant mass distributions
- 95% *CL* upper limits (pb): m_H=115 GeV (SM expected: 0.13 pb)
  - CDF: 3.4 (2.2) pb obs. (expect.)
  - DØ: 1.3 (1.1) pb obs. (expect.)

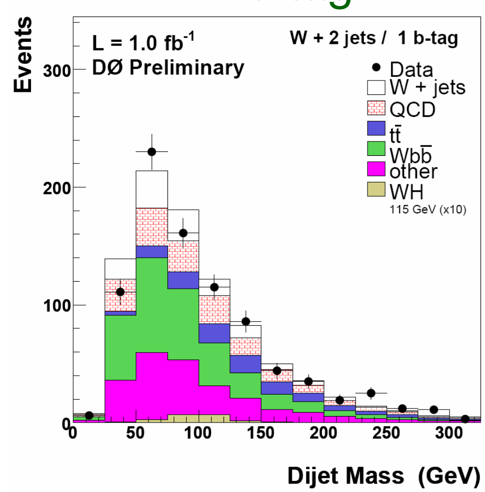
  $\sigma_{excl} / \sigma_{SM} \sim 8.8$ (best expect.)
  - Moriond ’07 vs ICHEP ’06
  - OR all triggers
  - NN b-tagger

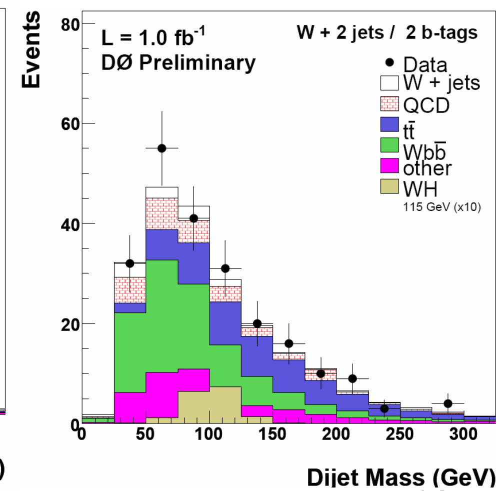
1 b-tag ICHEP ‘06 ≥ 2 b-tag





1 b-tag Moriond ‘07 2 b-tag





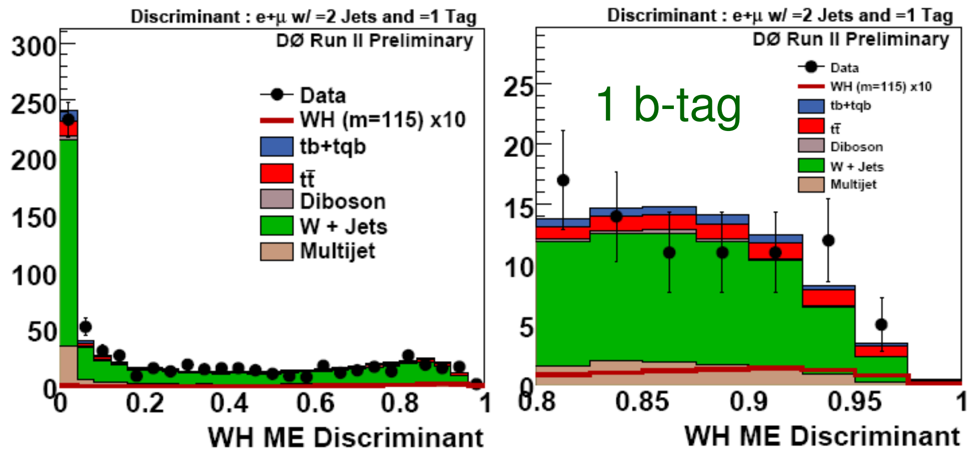
$WH \to l\nu b\bar{b},\ l = e, \mu$

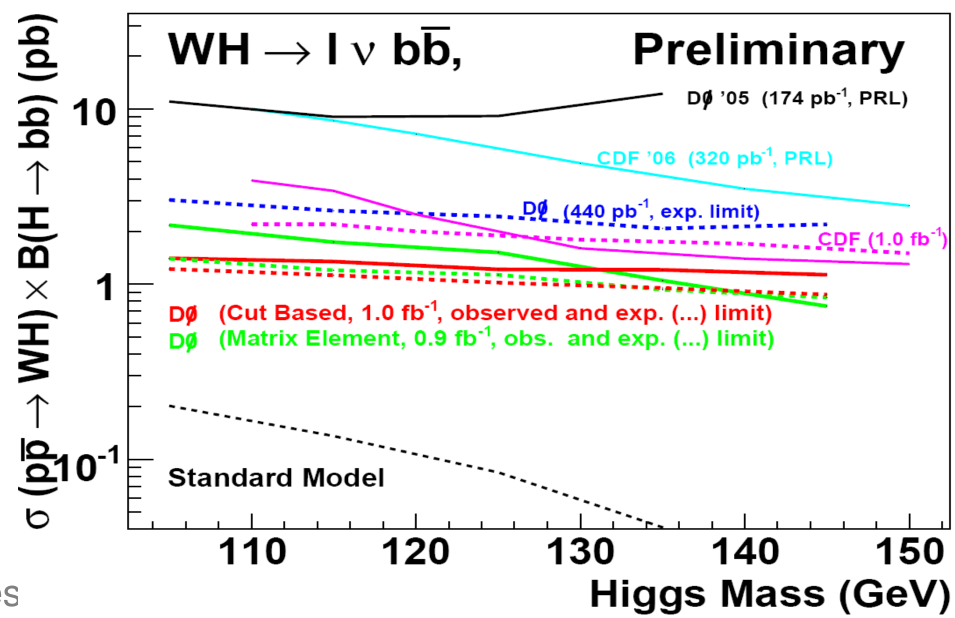
- Matrix Element: Use LO ME
  $\rightarrow$ event probability densities
  for signal and background

$$D(\vec{x}) = \frac{P_{WH}(\vec{x})}{P_{WH}(\vec{x}) + \sum_i c_i P_{Bi}(\vec{x})}$$

- Optimized for single top
  (will be re-optimized)
- Cross section limits derived from the per-channel discriminant distributions
- 95% *CL* upper limit (m_H=115 GeV)
  - 1.7 (1.2) pb obs. (expect.)
- Similar ratio to SM as cuts based analysis (~9)

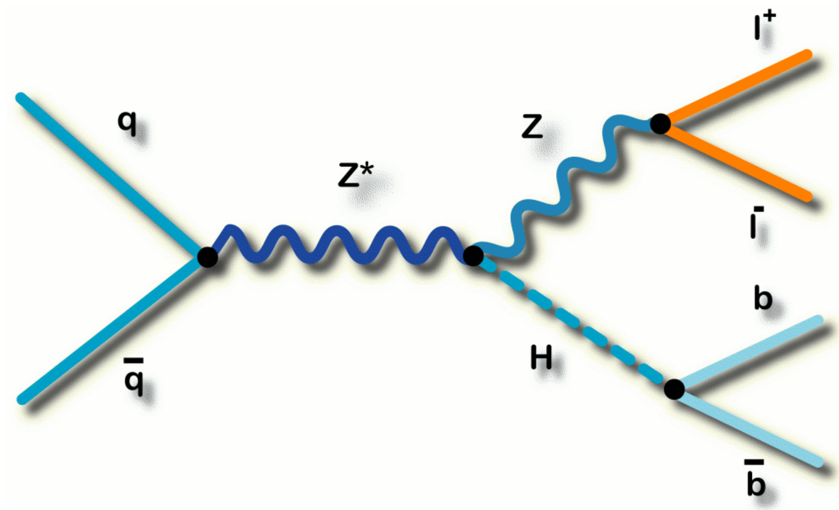
Matrix element analysis





$ZH \rightarrow ll b\bar{b}, \quad l = e, \mu$

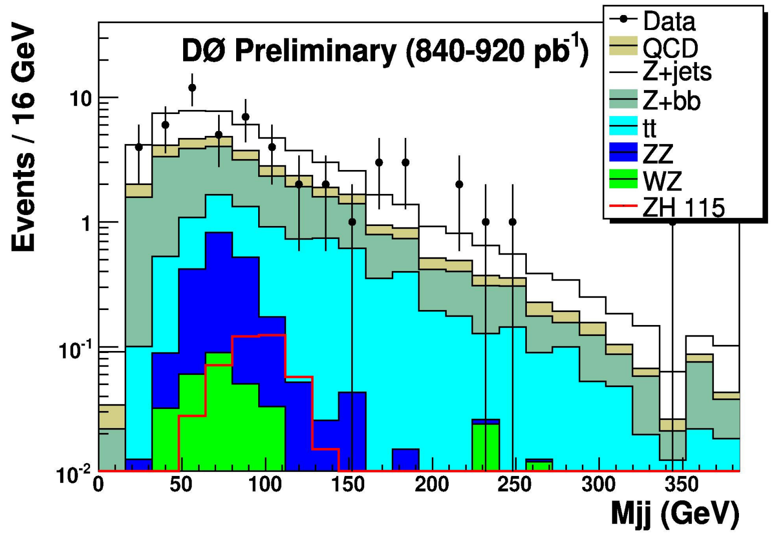
- Cleanest low mass channel, but low cross section
- Selection:
  - Loose lepton ID
    - $m_{ll} \sim M_Z$, opposite charge
    - Isolated from jets
  - Two jets:
    - p_T > 25,15GeV (CDF)
    - p_T > 20GeV (DØ)

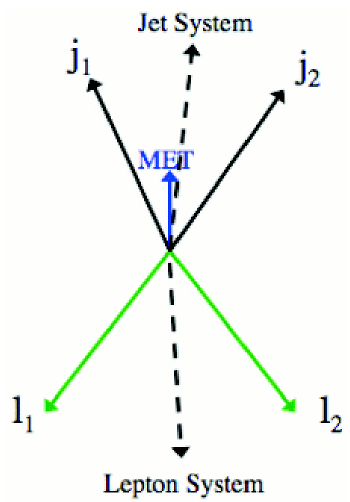


- Backgrounds:
  - Z+jets, top, WZ, ZZ, QCD
- Analyses (2006)
  - DØ: ≥ 2 b-tags. Cross-section limits from dijet invariant mass distribution within search window
  - CDF: 1 b-tag. 2-D NN to discriminate against two largest backgrounds (tt vs. ZH and Z+jets vs. ZH). Limits from NN distribution

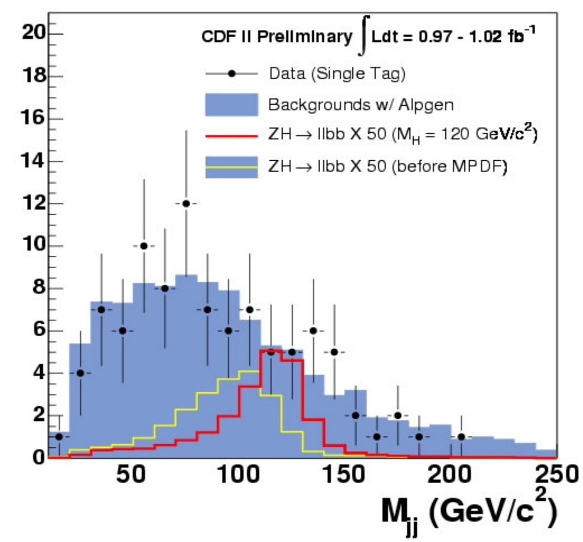
$ZH \rightarrow ll b\bar{b},\quad l = e, \mu$

- '2006' Results
  - 95% *CL* upper limits (pb):
    m_H=115 GeV (SM expected: 0.08 pb)
    - DØ: 2.7 (2.8) obs. (expect.)
    - CDF: 2.2 (1.9) obs. (expect.)
    - $\rightarrow \sigma_{excl} / \sigma_{SM} \sim 23$ (best expect.)





- CDF (Moriond QCD '07)
  - Adjust jets to balance missing E_T
    - Improved dijet mass resolution

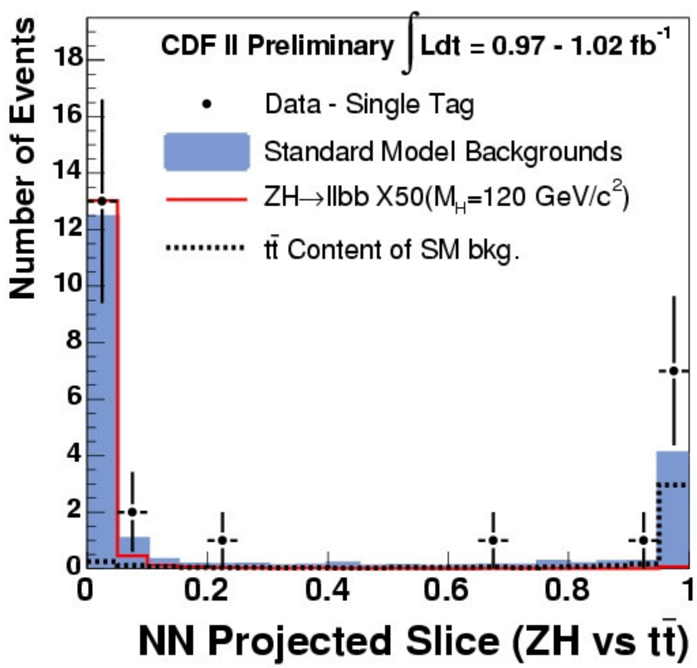


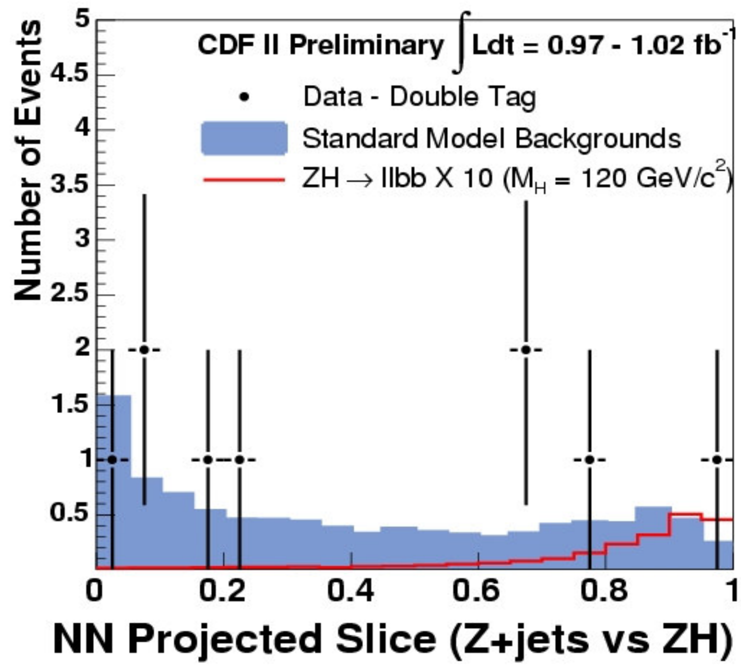
$ZH \to llb\bar{b}, \quad l = e, \mu$

- CDF Moriond QCD ’07 cont’d
  - Additionally - split sample into 1 & 2 b-tags, improved 2D NN
- m_H=115 GeV

  $\sigma_{excl} / \sigma_{SM} \sim 16$
  - Equivalent to x2 more data

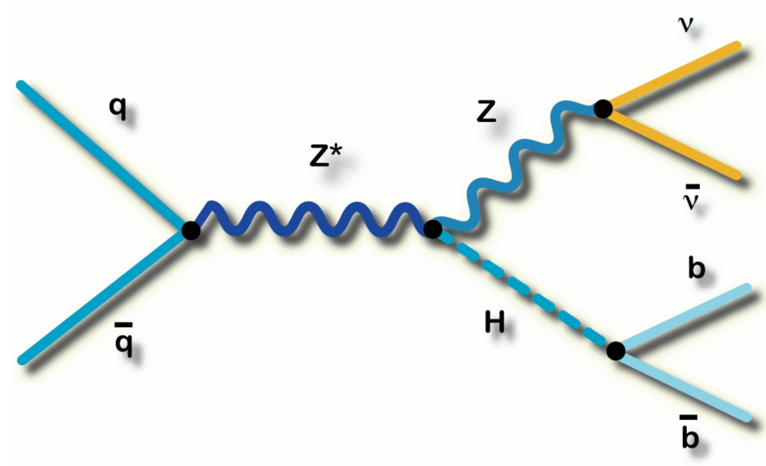
Again clear improvement in analyses





$ZH \to \nu\nu b\bar{b}, \quad WH \to (l^{\pm})\nu b\bar{b}$

- Larger cross-section & acceptance but hard - no visible leptons & only 2 jets in final state
  - Contribution from WH when l missed

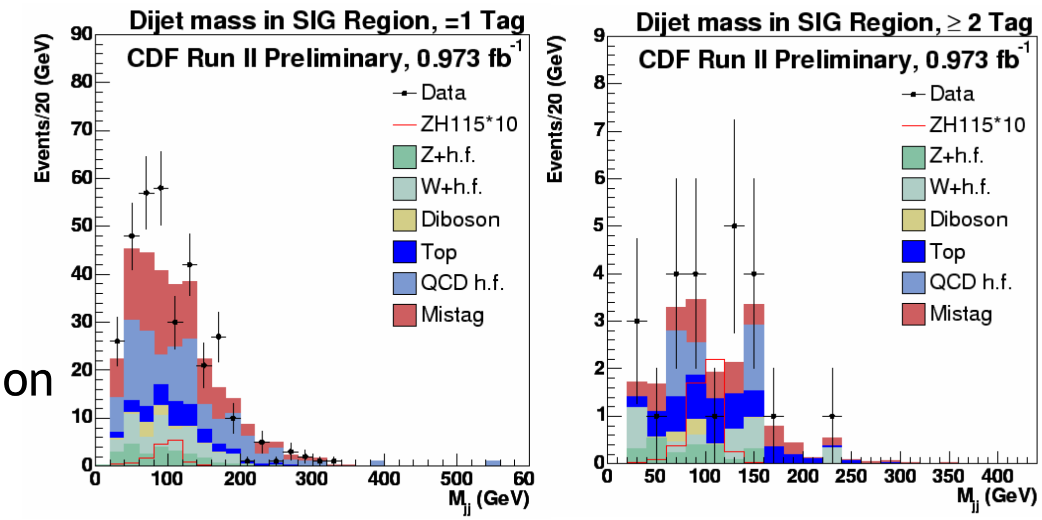


- Selection
  - Two jets
    - CDF: > 60, 20 GeV; DØ: > 20GeV
  - Missing E_T (Not aligned in ϕ with jets)
    - CDF: > 75 GeV; DØ: > 50GeV
  - B-tags
    - CDF: Separate 1 & 2 b-tag sample; DØ : 1 tight + 1 loose
  - Veto on isolated leptons, max H_T ($=\Sigma P_T$)

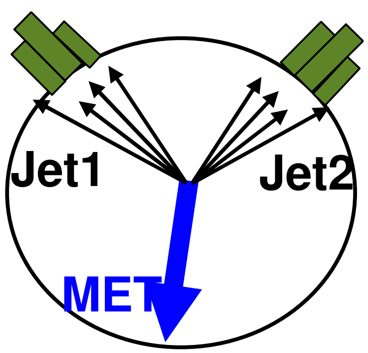
- Backgrounds
  - Physics: W/Z + jets, di-boson, top – measured with Monte Carlo
  - Instrumental: Mis-measured missing E_T together with QCD jets – determined from data

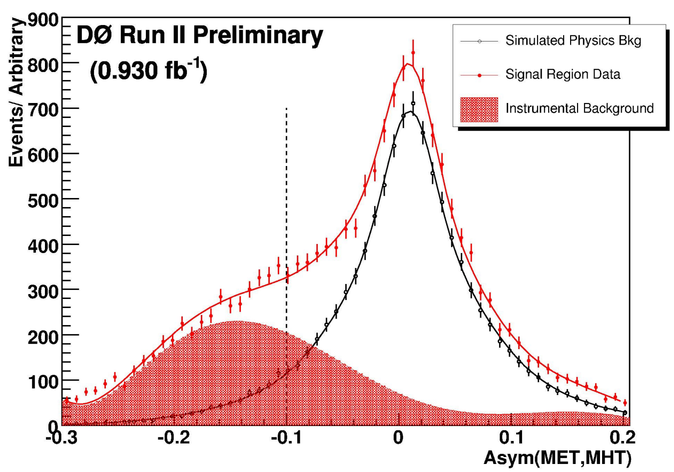
$$ZH \to \nu\nu b\bar{b}, \quad WH \to (l^{\pm})\nu b\bar{b}$$

- CDF (ICHEP'06)
  - Heavy flavour (h.f.) bkgs from MC
  - Light jets from mistags, estimated from data
  - h.f. normalized in control region



- DØ (Spring'07)
  - Define 2 missing energy variables
    - MHT – measured with jets
    - MET – direct from calorimeter cells
    - Asymmetry isolates mis-measured jets

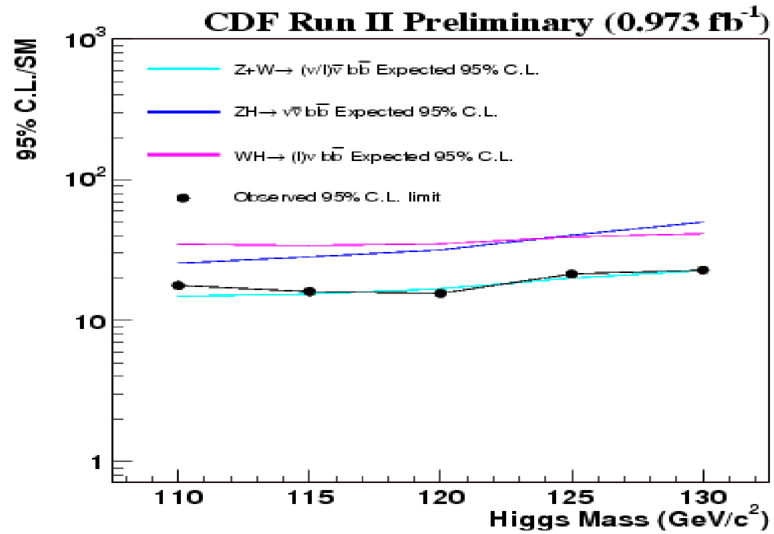


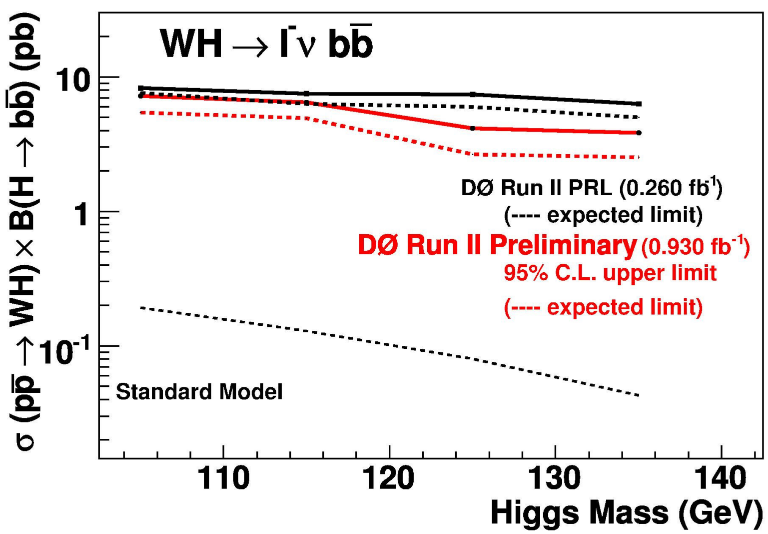


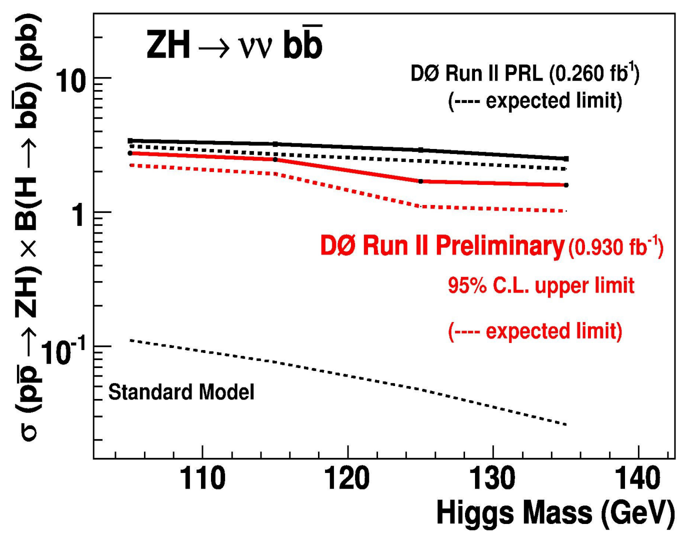
$ZH \to \nu\nu b\bar{b},\ \ WH \to (l^{\pm})\nu b\bar{b}$

- Cross section limits derived from invariant mass distributions
  - Set limits for ZH and WH with the l unreconstructed
- m_H=115 GeV

  $\sigma_{excl} / \sigma_{SM} \sim 10$ (best expect.)



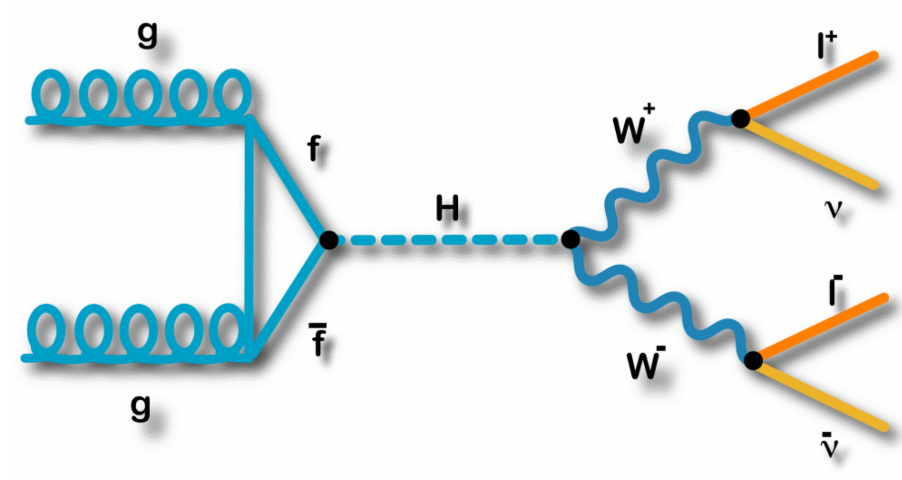




High mass SM Higgs

- Introduction
- Low mass
- High mass
  - $\boxed{H \to WW}$
- Combination

Main search channel for m_H > 135GeV



Use ee, eμ, μμ channels

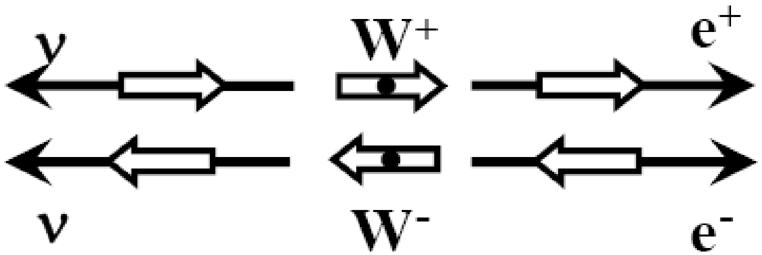
Signature:

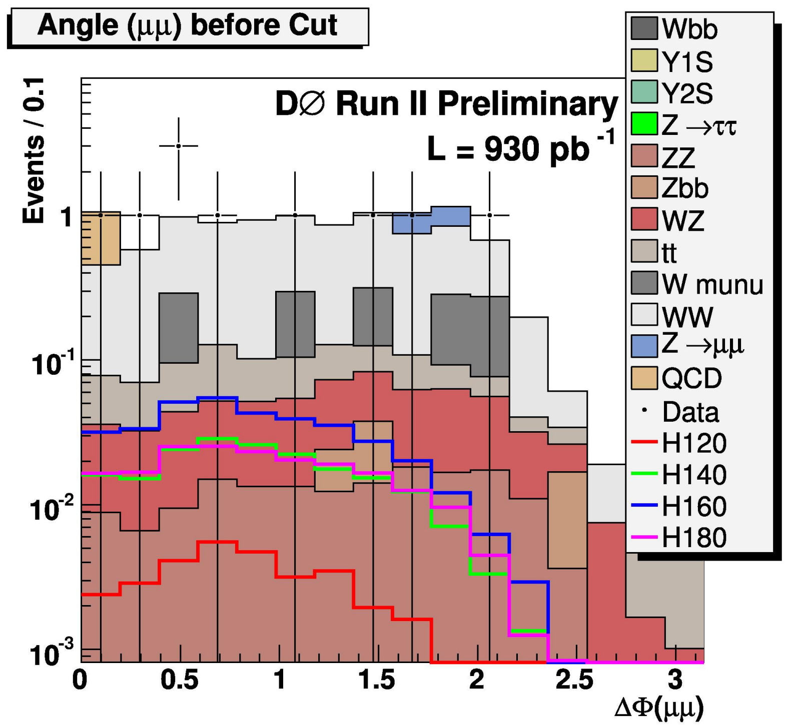
High P_T opposite sign leptons (10-20GeV)

Missing E_T

$H \to WW^{(*)} \to l^+ l^- \nu \bar{\nu}, \quad l = e, \mu$

- Analyses: CDF: cuts based (EW '07), ME (QCD '07) DØ: cuts based (ICHEP '06)
- Backgrounds
  - Drell-Yann, QCD, tt, SM WW dominates
- Selection
  - Missing $E_T > \approx$ 20GeV, isolation
  - Veto on # of jets, H_T ($= \Sigma P_T$)
  - m_H dependent cuts (P_T, m_{ll} etc)
  - *WW* from spin 0 Higgs
    - Leptons prefer to point in same direction

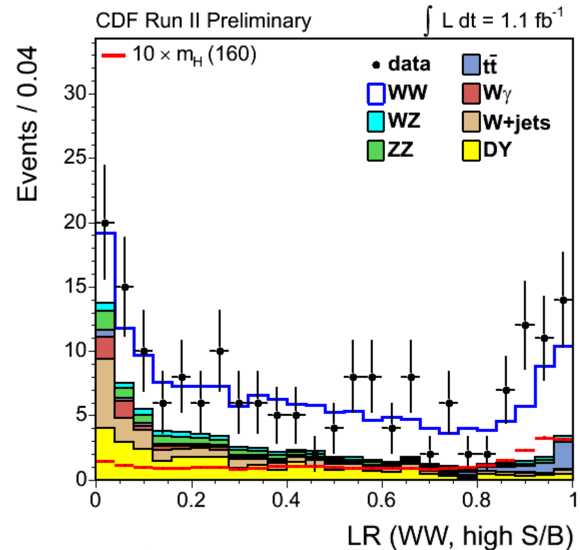




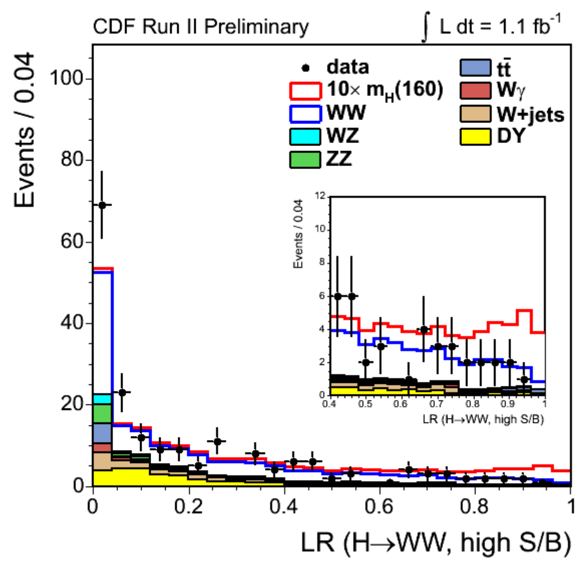
  - di-lepton opening angle $\Delta\phi_{ll}$ discriminates against dominant WW bkg.
  - Cross section limit derived from $\Delta\phi_{ll}$ distribution (cuts based)

$H \to WW^{(*)} \to l^+ l^- \nu \bar{\nu}, \;\; l = e, \mu$

- CDF Moriond QCD '07
  - Improved lepton acceptance
  - Matrix Element approach
    - Use observed leptons & missing E_T (x_{obs})
    - Integrate over LO theory predictions for WW, ZZ, W+γ, W+jet, 10 Higgs masses
    - Construct LR discriminant from probabilities



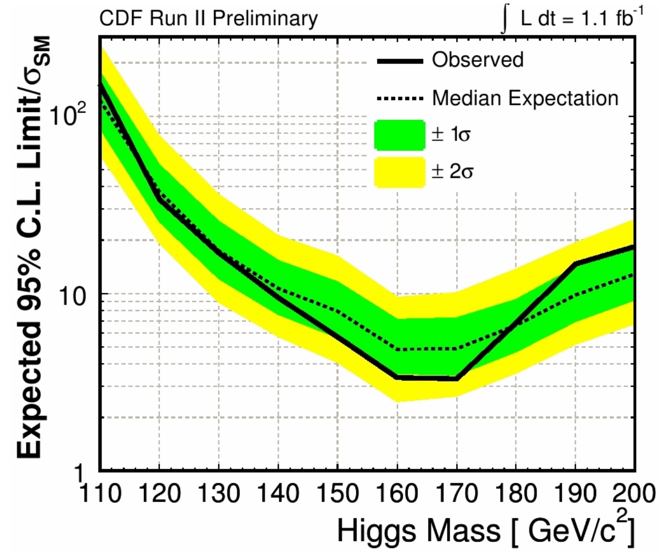
$$LR(x_{obs}) = \frac{P_H(x_{obs})}{P_H(x_{obs}) + \Sigma_i k_i P_i(x_{obs})}$$

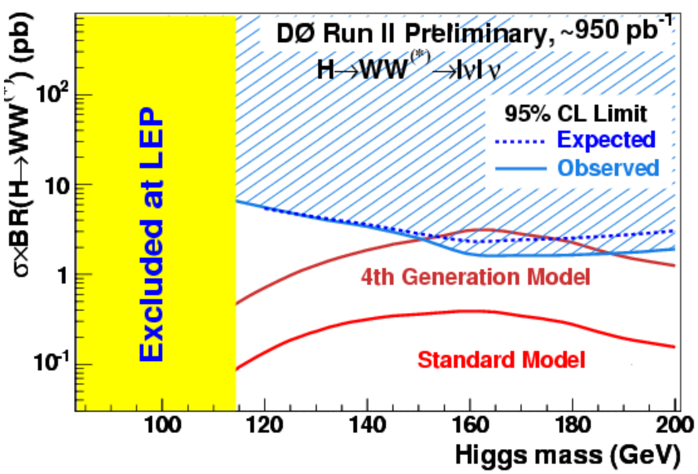


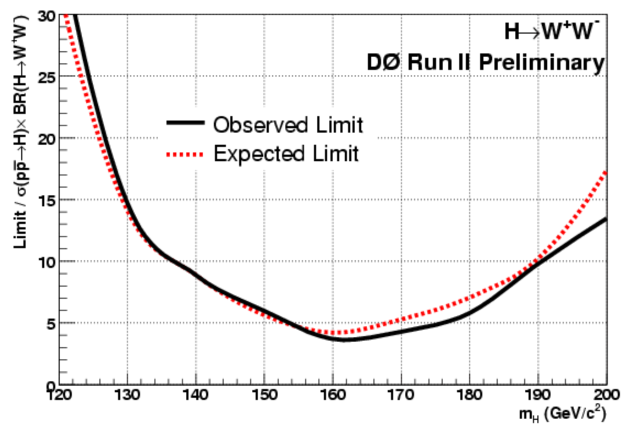
  - Validate LR for background
  - Limit set by fitting LR distribution

$H \to WW^{(*)} \to l^+ l^- \nu \bar{\nu}, \quad l = e, \mu$

- m_H= 160 GeV
  - CDF result, Matrix Element:
    - x3.4 (x4.8) obs. (expect.) SM
  - Cuts based:
    - x9.2 (6.0) obs. (expect.) SM
  - DØ cuts based:
    - x3.7 (4.2) obs. (expect.) SM



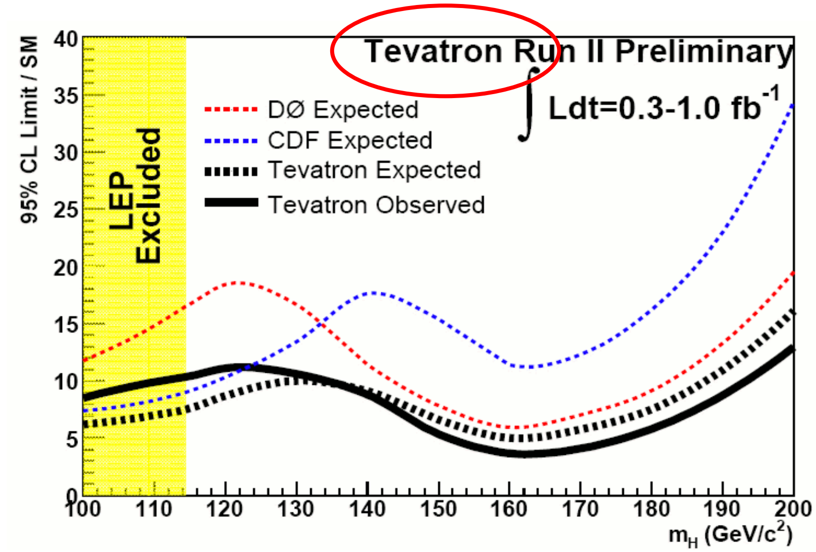


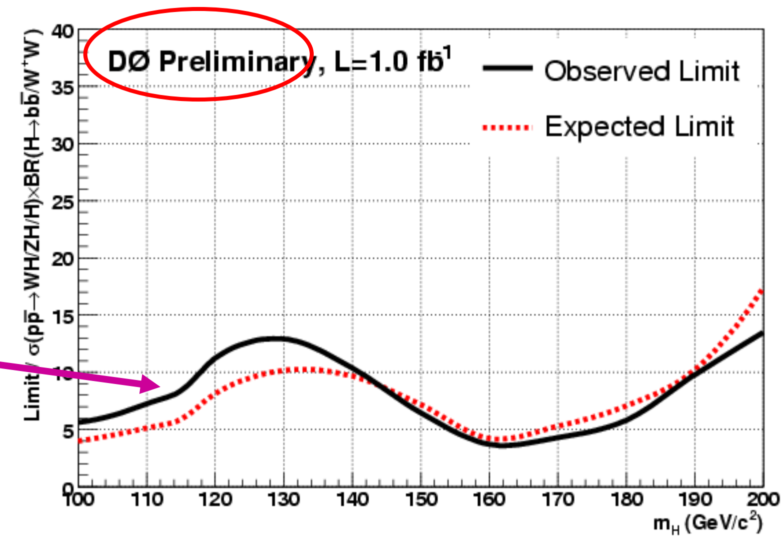


- 4^{th} generation model already excluded for m_H = 150 – 185 GeV

Combination

- Summer '06 - 1st Tevatron combination
  - Like 1 experiment with ~1.3fb^{-1}
- Much progress since
  - Better sensitivity in all channels
  - Advanced analysis techniques
    - NN – b-tagging or event selection
    - ME methods
  - x~2 more luminosity
- Combinations ongoing
  - DØ alone now has tighter limits
    - Factor of 3 better at low m_H
    - Better than √L gain





Non-SM Higgs

- Introduction
- SM Higgs
- Non-SM Higgs
  - Minimal Supersymmetric Standard Model (MSSM)
    - Introduction
    - Neutral Higgs bosons (ϕ) searches

      $\phi \to \tau\tau$

      $b\phi \to bbb$
  - Fermiophobic Higgs
- Prospects & Conclusions

Higgs bosons in the MSSM

- In MSSM have 2 Higgs doublets
  - H_u (H_d) couple to up- (down-) type fermions
  - Ratio of VEV's: $\tan\beta = \langle H_u \rangle / \langle H_d \rangle$
  - 5 Higgs particles after the EWSB: h, H, A, H^+, H^-
  - h has to be light: $m_h <$ ~140 GeV
  - At tree level, 2 independent parameters: m_A and $\tan\beta$

- At large tan β:
  - Coupling of A, h/H to down-type fermions, e.g. *b*-quark, enhanced wrt SM

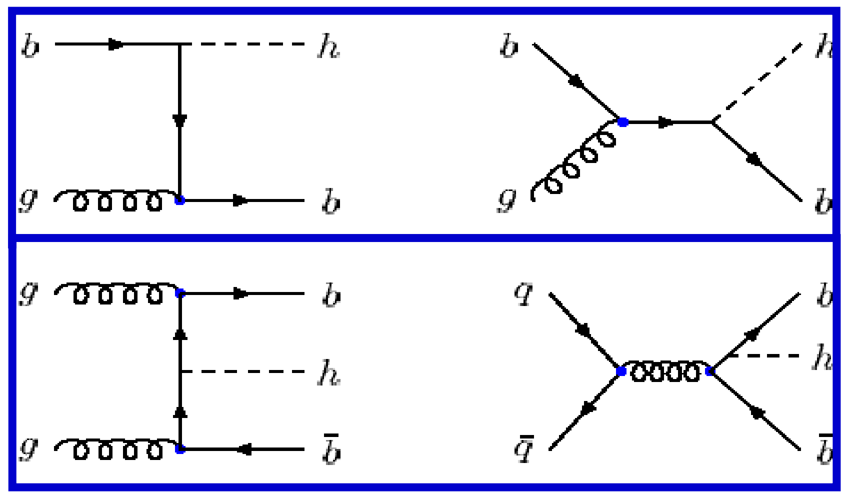
    ⟶ production amplitude ~tanβ ⟶ production cross section ~$\tan^2\beta$
  - h/H & A (denoted by φ) ~degenerate in mass ⟶ further increase in cross-section
- For low & intermediate masses
  - Br ($\phi \to \tau\tau$) ~10%, Br ($\phi \to bb$) ~90%

MSSM Higgs boson production

- Signature
  - Higgs decays to 2 τ's
  - Further decays of τ's define final states

$\phi \rightarrow \tau\tau$

  - 2 high P_T b-jets from Higgs
  - 1 or 2 extra b-quarks
  - Search for peak in dijet invariant mass



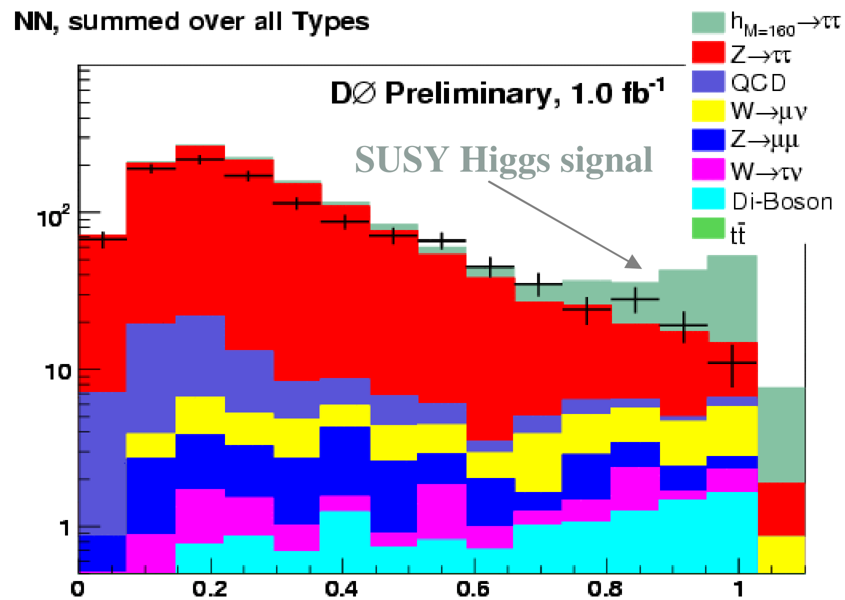
$\phi \rightarrow bb$
3b

$\phi \rightarrow bb$:
4b

Similar overall sensitivities

Neutral MSSM Higgs → $\tau_l \tau_{had}$

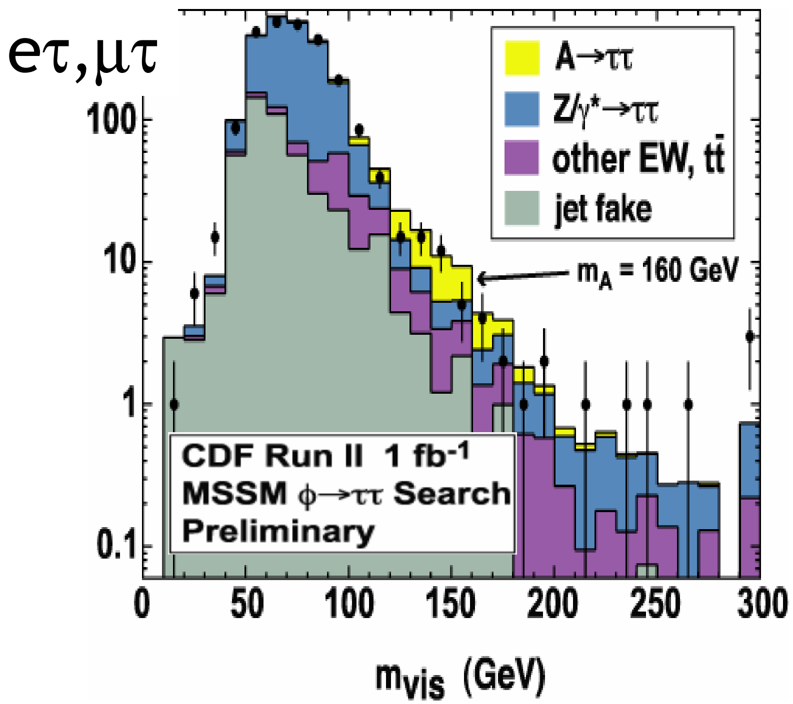
- Main bkgs.: $Z \to \tau\tau$ (irreducible), W+jets, Z →ee,μμ, multijet, di-boson
- DØ (μ channel only):
  - Only 1 isolated μ separated from the hadronic τ with opposite sign
  - τ identification: NN based
  - M_W < 20 GeV removes most of remaining W boson bkg.
  - Optimized NNs to separate signal from bkg.

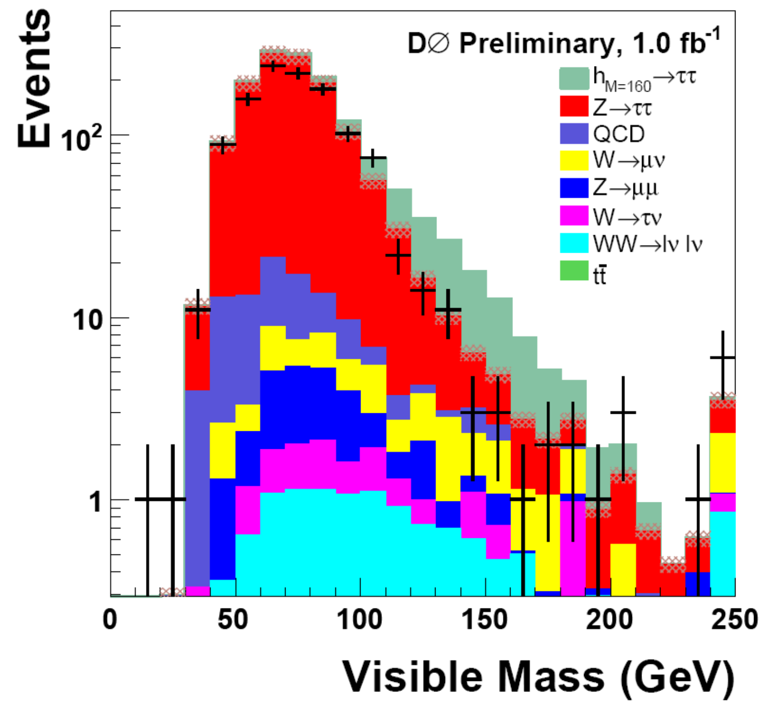


- CDF (e, μ, e+μ channels)
  - Isolated e or μ separated from hadronic τ with opposite sign
  - τ identification: Variable-size cone algorithm
  - Jet background suppression: $|p_t^l| + |p_t^{had}| + |\not\!\!E_T| > 55$ GeV
  - remove most of W bkg. by cutting on relative directions of the visible τ decay products and missing E_T

Neutral MSSM Higgs → $\tau_l\tau_{had}$

- CDF: Limits derived from m_{vis} distribution
  - Observed limits weaker than expected due to an excess in data sample, but significance ≤ 2σ once all search channels & windows considered

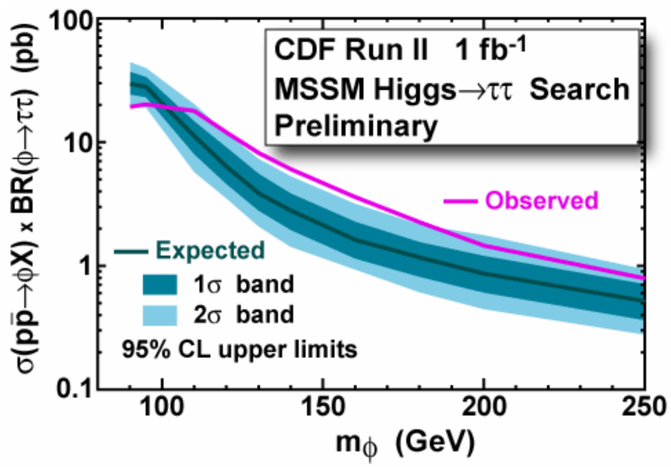


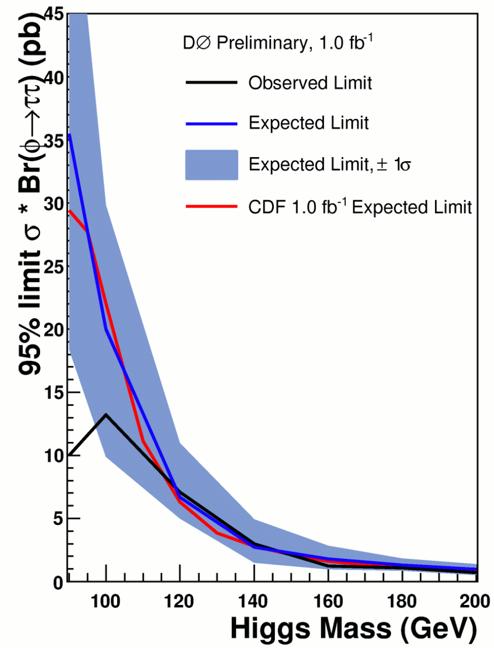


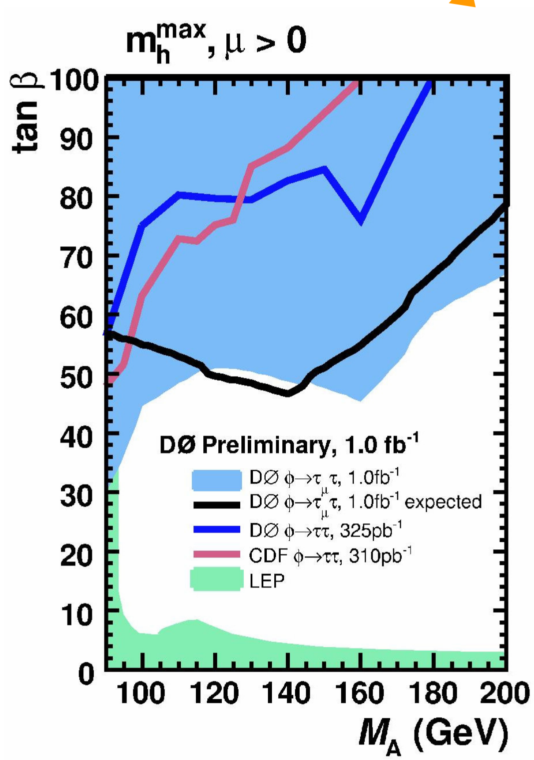
- DØ: Cross-section limits: NNs for the different tau types

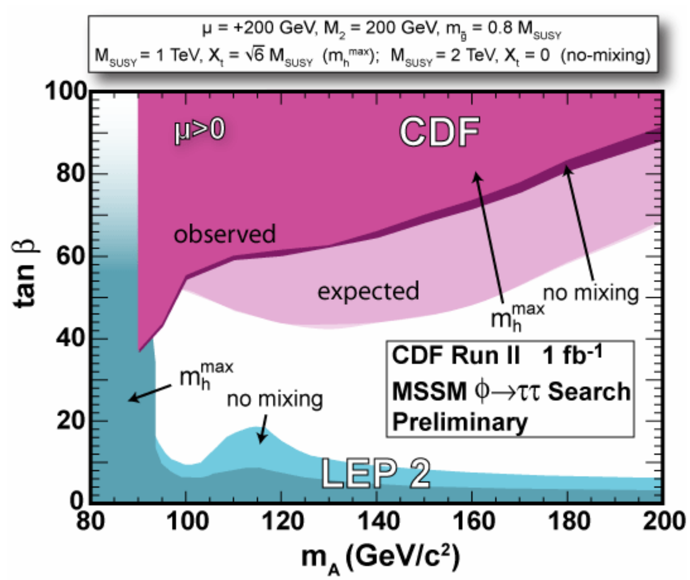
Neutral MSSM Higgs → $\tau_l \tau_{had}$

- Proceed to set limits
- $\sigma \times \mathrm{Br}\ (\phi \to \tau\tau)$ →
- MSSM parameter space





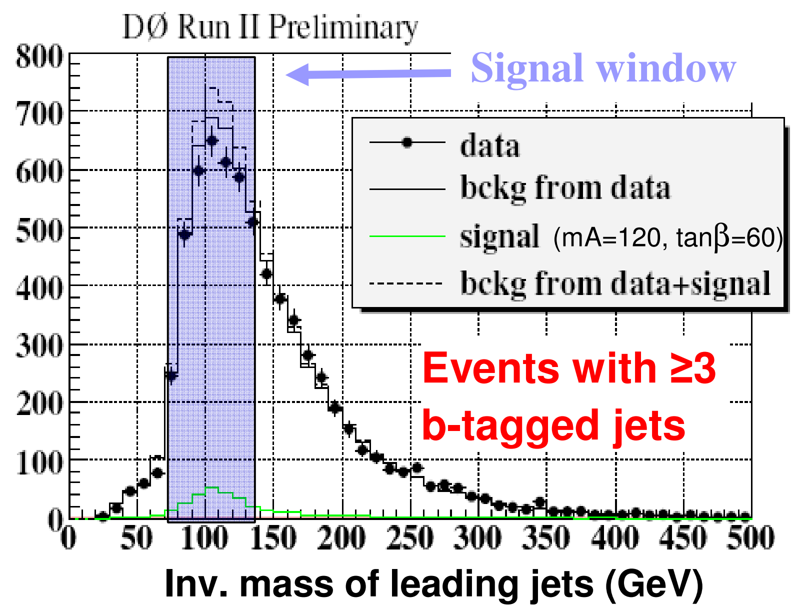




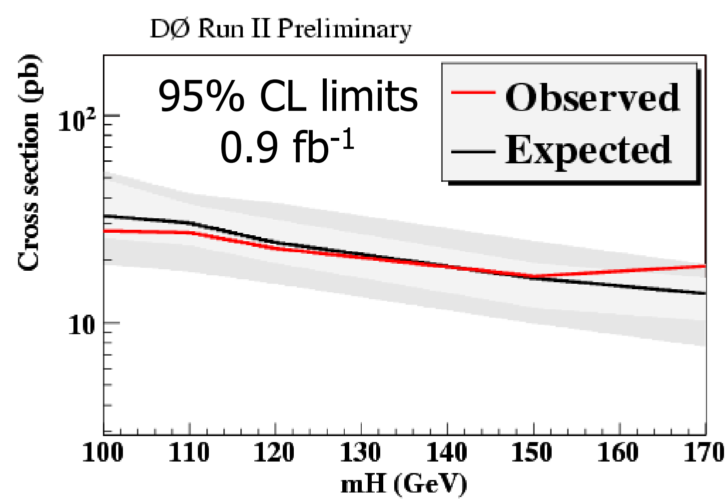
- Use no-mixing & m_h^{max} benchmark scenarios
- $90 < m_A < 200$ GeV, $\tan\beta > 40$-60 excluded

Neutral MSSM Higgs → bb + b[b]

- DØ: ICHEP '06
- ≥ 3 b-tagged jets: p_T> 40, 25, 15 GeV
  - Invariant mass of 2 leading jets peaks at Higgs mass
- Backgrounds from data
  - Shape estimated from double-tagged dijet mass spectrum
  - Rate normalized outside signal window



- Agreement between data & predicted background → set upper limits
- Preliminary analysis being optimized

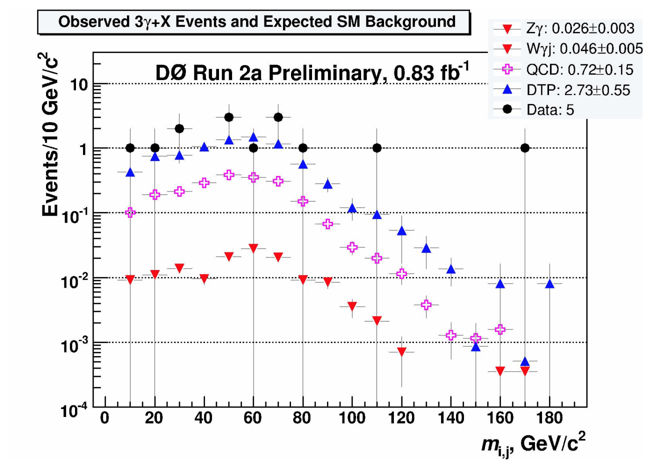


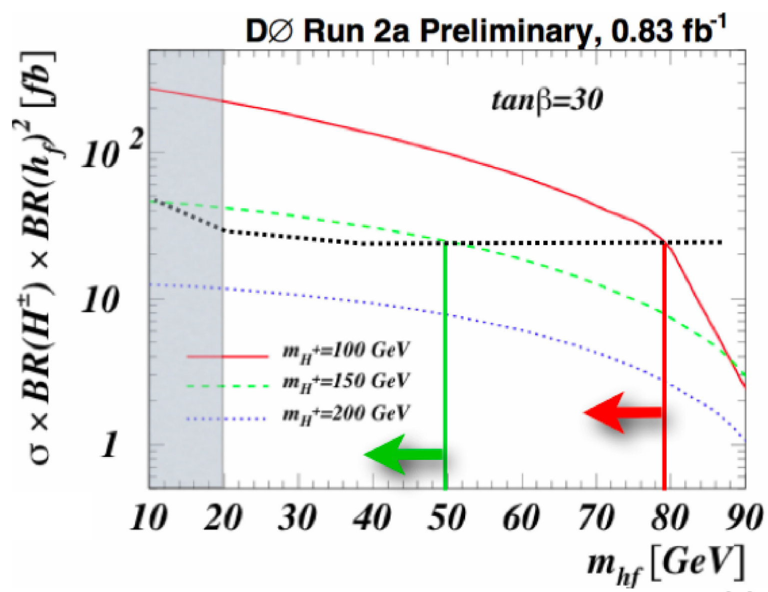
Fermiophobic Higgs → 3γ + X

- Some extensions of SM: coupling of higgs to fermions suppressed
- Search for the channel:

$$p\bar{p} \rightarrow h_f H^{\pm} \rightarrow h_f h_f W^{\pm} \rightarrow \gamma\gamma(\gamma) + X$$

- Cuts
  - 3γ with |η|<1.1, $E_T^{1,2,3}$ > 30, 20, 15 GeV
- Backgrounds
  - Jets or electrons misidentified as γ and direct 3γ production
  - Estimated from data
- H_T (3γ) > 25GeV
  - 0 events seen for 1.1 expected
  - 95% CL limit: σ(hH±) < 25.3fb
- Exclusion on mass of h_f for different charged Higgs masses ($m_{H^{\pm}}$) & tanβ





Prospects and Conclusions

- Introduction
- SM Higgs
- Non-SM Higgs
- **Prospects and Conclusions**

Prospects - SM Higgs

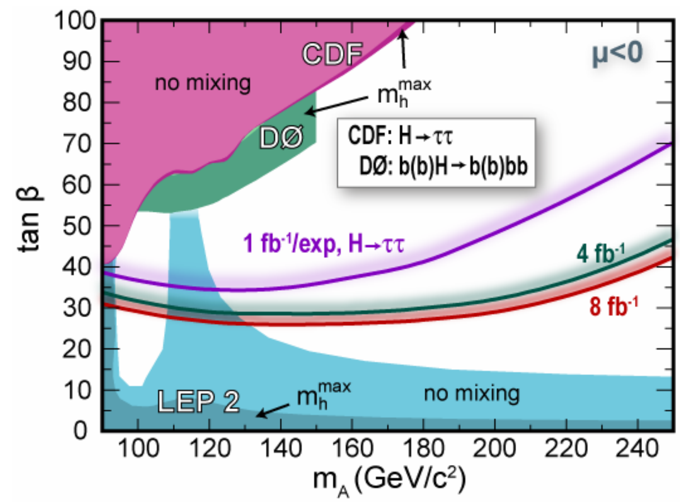
- Rapid evolution
  - Some single channels now as powerful as Tevatron results of ICHEP '06
- More sensitivity will be gained by
  - Larger data sets (~ x8 in total)
  - Include more channels e.g. τ final states
  - Improved di-jet mass, b-tagging and simulation
  - Improved analyses, especially use of multivariate techniques: e.g. NN, ME and decision trees
    - Recent single top and WZ results important step in use of such techniques to extract small signals in large backgrounds
- Need ~3fb^{-1} to reach 95% exclusion at m_H= 115GeV or m_H = 160GeV
- Expect updated Tevatron combination for summer '07

Prospects - MSSM Higgs

- 1st results from $1fb^{-1}$ show promising sensitivity
  - Similar approach to improvements as for SM Higgs

- Short term (this summer)
  - New $\phi \rightarrow bb + b[b]$
    - From both experiments
  - New $\phi \rightarrow bb + b[b]$ &
    $\phi \rightarrow \tau\tau$ (& $b\phi \rightarrow b\tau\tau$) combination

1st combination - low statistics



- Longer term
  - Up to m_A ~250 GeV for large tanβ
  - Down to tanβ ~20 for low m_A
  - Or discovery

Conclusions

- Tevatron and CDF/ DØ experiments performing very well
  - Over 2.5 times more data under analysis
- Wide range of Higgs searches performed by CDF & DØ with up to 1 fb^{-1} Run II data:
  - No deviations from SM expectations observed
  - No signal observed in MSSM Higgs search, but already powerful!
- Rapid evolution in sensitivity
  - Increased use of multivariant techniques
- 1st Tevatron SM combination from Summer '06
  - Some individual channels already have similar limits!
- More work needed to reach desired sensitivity, but clear roadmap
  - At m_H=115GeV or 160GeV need ~3fb^{-1} for 95% exclusion, ~8fb^{-1} for 3σ
  - Updated CDF and DØ combinations soon

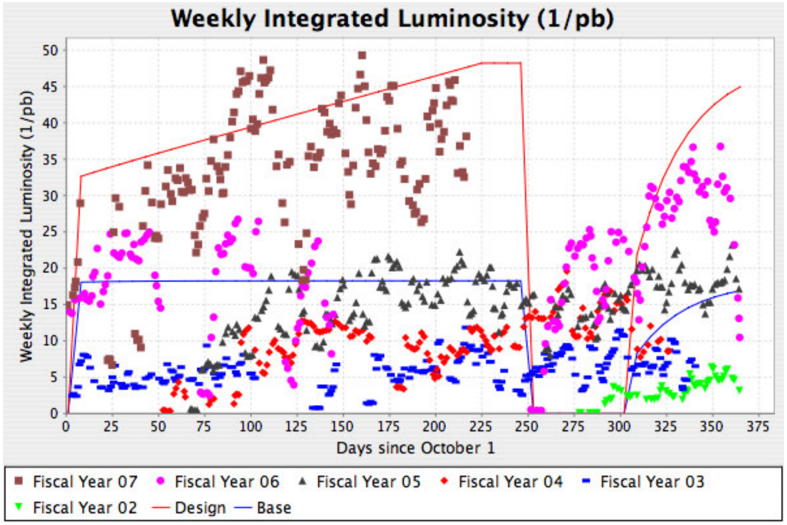
Very exciting times ahead!

And as the last speaker..

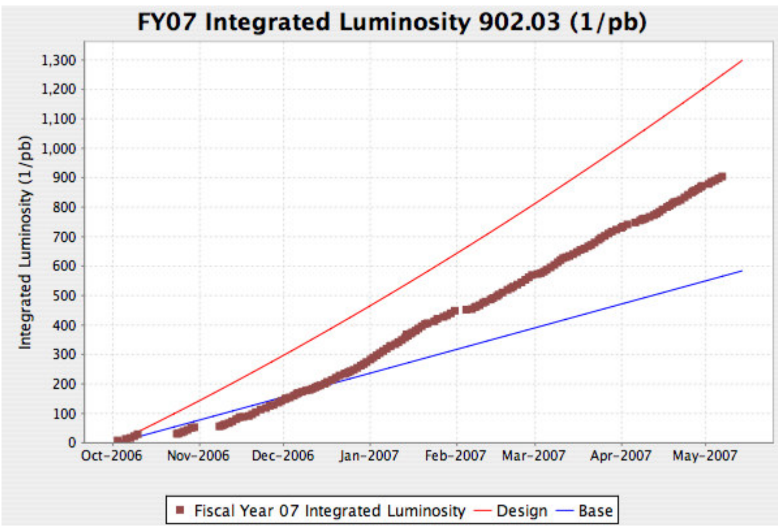
Many thanks to our hosts and the local organising committee

Backup slides

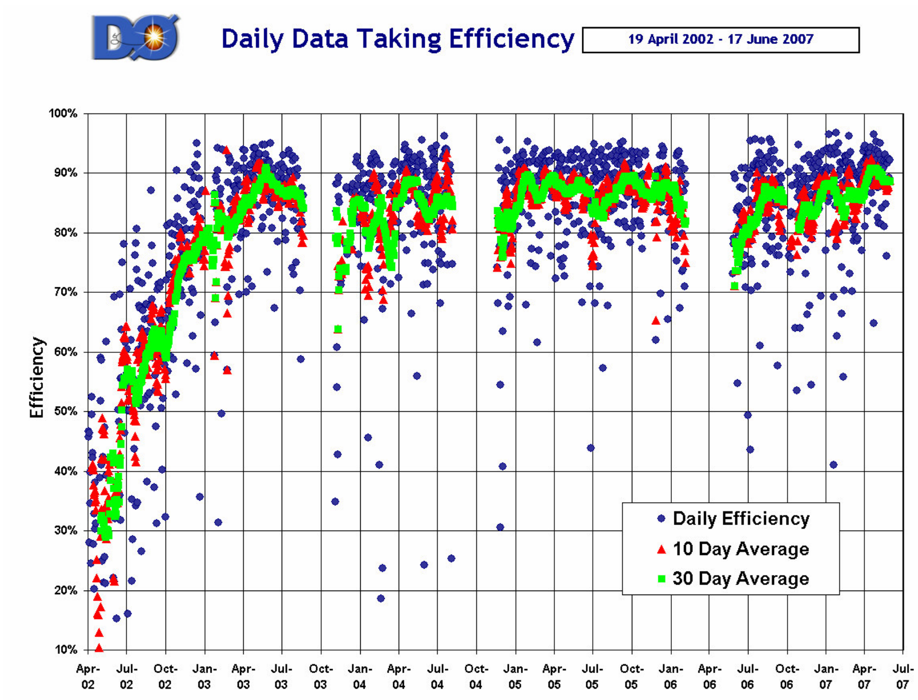
Tevatron & DØ



Weekly Integrated Luminosity (1/pb)
Weekly Integrated Luminosity (1/pb)
Days since October 1
Fiscal Year 07
Fiscal Year 06
Fiscal Year 05
Fiscal Year 04
Fiscal Year 03
Fiscal Year 02
Design
Base



FY07 Integrated Luminosity 902.03 (1/pb)
Integrated Luminosity (1/pb)
Oct-2006
Nov-2006
Dec-2006
Jan-2007
Feb-2007
Mar-2007
Apr-2007
May-2007
Fiscal Year 07 Integrated Luminosity
Design
Base



Daily Data Taking Efficiency
19 April 2002 - 17 June 2007
Efficiency
Daily Efficiency
10 Day Average
30 Day Average

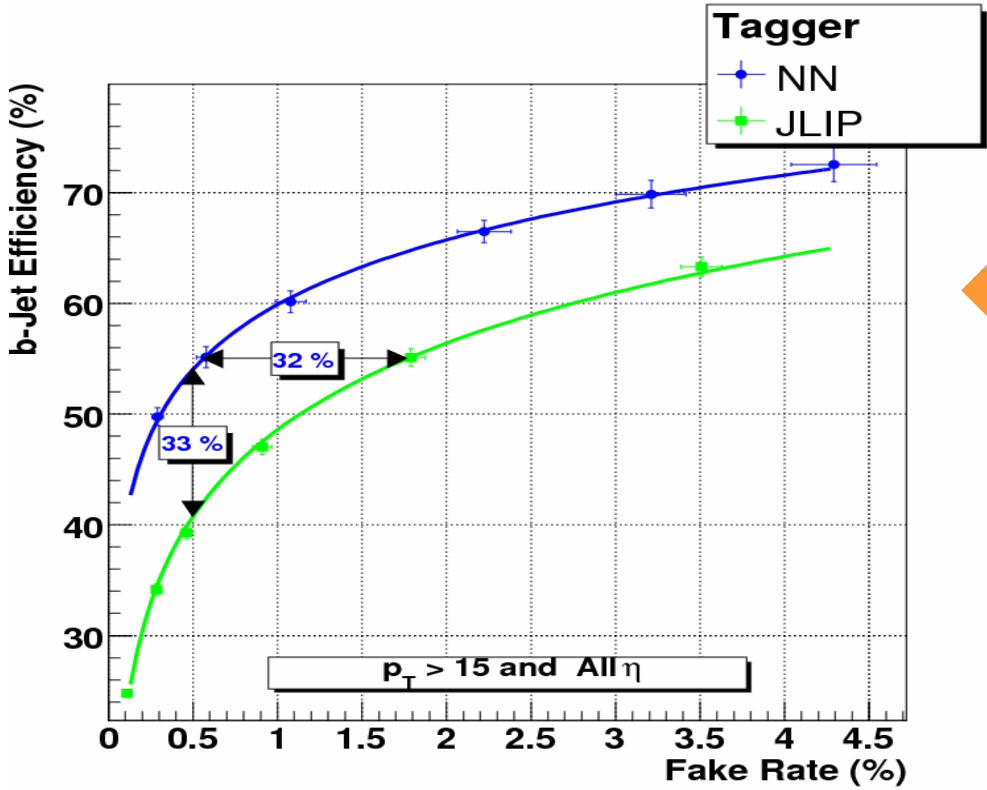
DØ B-tagging

Several mature algorithms used:

- 3 main categories:
  - Soft-lepton tagging
  - Impact Parameter based
  - Secondary Vertex reconstruction

Combine in Neural Network:

- vertex mass
- vertex number of tracks
- vertex decay length significance
- chi2/DOF of vertex
- number of vertices
- two methods of combined track impact parameter significances



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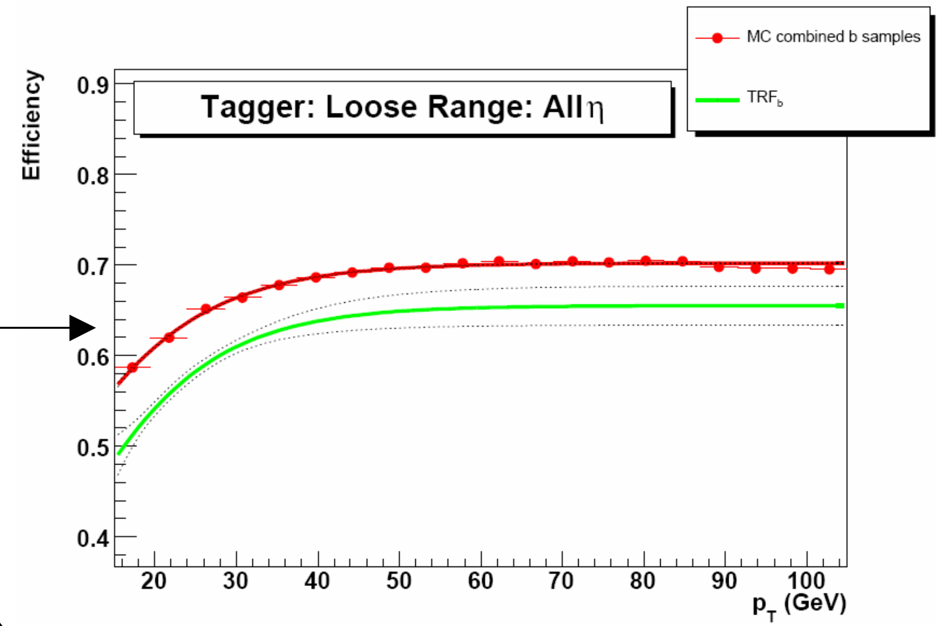
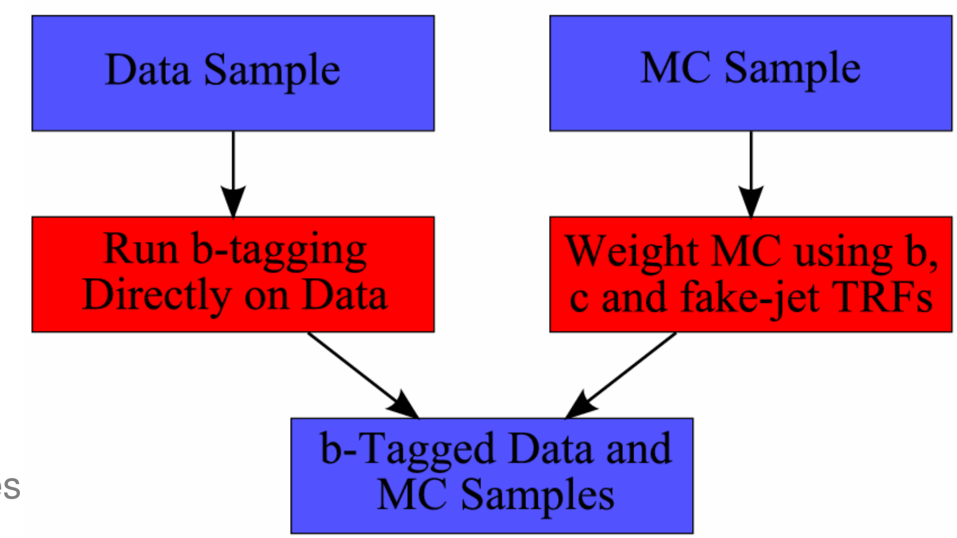
B-tagging - (DØ) Certification

- Have MC / data differences - particularly at a hadron machine
  - Measure performance on data
    - Tag Rate Function (TRF) Parameterized efficiency & fake-rate as function of p_T and η
  - Use to correct MC b-tagging rate



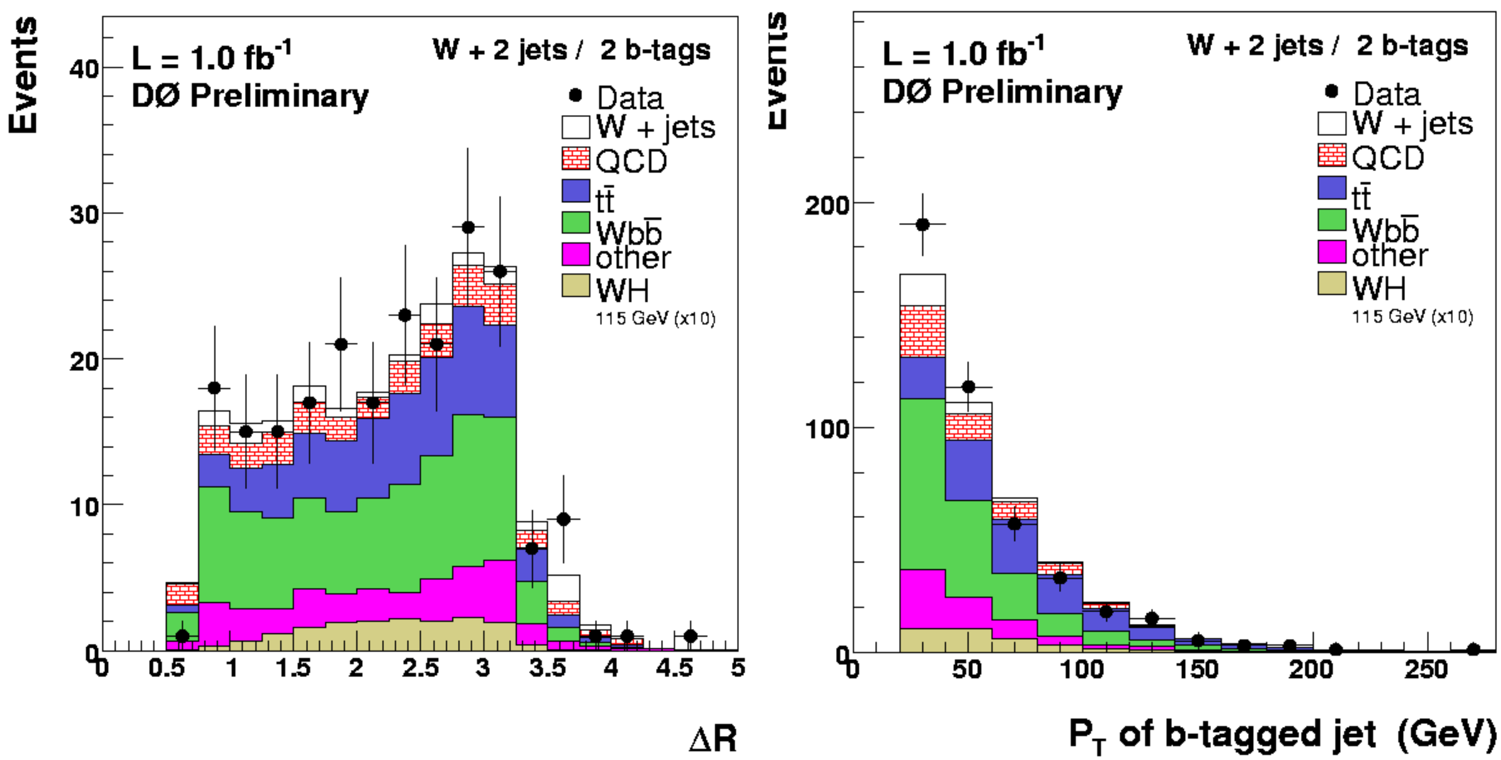
- b and c-efficiencies
  - Measured using a b-enriched data sample
- Fake-rate
  - Measured using QCD data



DØ B-tagging gains

- Update b-tagging optimization (as compared to Single-Top result)
  - Use asymmetric *TIGHT* + *LOOSE* b-tagging thresholds for double-tagged jet sample (*gain ~40% in sensitivity*)
  - For WH → lνbb, separate orthogonal 2 b-tag and 1 b-tag samples to salvage lost efficiency (*gain ~15% in sensitivity*)

W+ 2 b-tag control plots



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SM Summary

Analysis	CDF limit ($1fb^{-1}$) Factor above SM Observed (expected)	DØ limit ($1fb^{-1}$) Factor above SM Observed (expected)
Z/WH→MET+bb @ 115 Technique: M_{jj}	16 (15)	14 (9.6)
WH⟶lnbb @ 115 Technique: M_{jj} Technique: ME	26 (17) ---	11 (8.8) 12 (9.5)
ZH⟶llbb @ 115 Technique: M_{jj} Technique: NN2D	--- 16 (16)	23 (22) ---
H⟶WW⟶ll@ 160 Technique: $\Delta\phi$(l,l) Technique: ME	9.2 (6.0) 3.4 (4.8)	3.7 (4.2) ---
h⟶ $\tau\tau$ @ 160 μ<0, no mixing	tan β< 69 (47)	tan β< 44 (54)

SM evolution

- Based on DØ current limits, what could we achieve?

Ingredient	Equiv Lumi Gain	Xsec Factor MH=115 GeV	Xsec Factor MH=160 GeV
Today with 1fb^{-1}	-	$\boxed{5.9}$	$\boxed{4.2}$
Lumi = 2 fb^{-1}	2	4.2	3.0
b-Tag (Shape + LayerØ)	1.5	3.4	3.0
Multivariate Techniques	1.7	2.6	2.3
Improved mass resolution	1.5	2.1	2.3
New Channels	1.3/1.5	1.9	1.9
Reduced systematics	1.2	1.7	1.7
Two Experiments	2	1.2	1.2

→ need ~3 fb^{-1} to reach 95 % C.L. exclusion

MSSM benchmarks

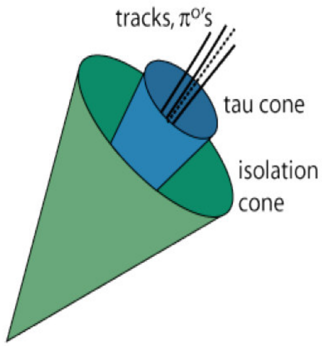
- Five additional parameters due to radiative correction
  - M_{SUSY} (parameterizes squark, gaugino masses)
  - X_t (related to the trilinear coupling $A_t \rightarrow$ stop mixing)
  - M_2 (gaugino mass term)
  - μ (Higgs mass parameter)
  - M_{gluino} (comes in via loops)

	m_h-max	no-mixing
M_{SUSY}	1 TeV	2 TeV
X_t	2 TeV	0
M_2	200 GeV	200 GeV
μ	±200 GeV	±200 GeV
$m_{\tilde{g}}$	800 GeV	1600 GeV

- Two common benchmarks
  - Max-mixing - Higgs boson mass m_h close to max possible value for a given $\tan\beta$
  - No-mixing - vanishing mixing in stop sector $\rightarrow$ small mass for h

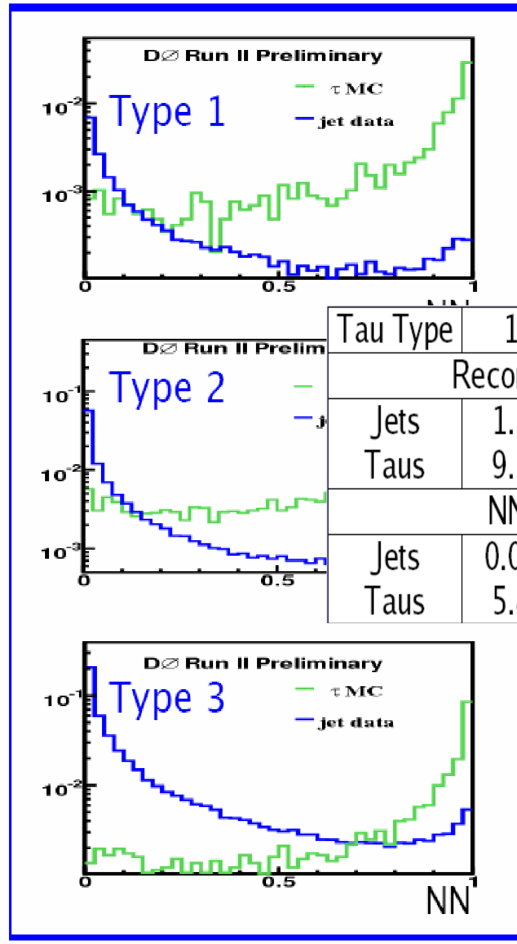
Tau ID

- CDF: Isolation based



- Require 1 or 3 tracks, p_T > 1GeV in the isolation cone
  - For 3 tracks total charge must be ±1
  - p_T^{had} > 15 (20) GeV for 1 (3) prongs
  - M^{had} < 1.8 (2.2) GeV
- Reject electrons via E/p cut
- Validated via W/Z measurements
- Performance
  - Efficiency ~ 40-50%
  - Jet to tau fake rate ~0.001-0.005

- DØ: 3 NN's for each tau type

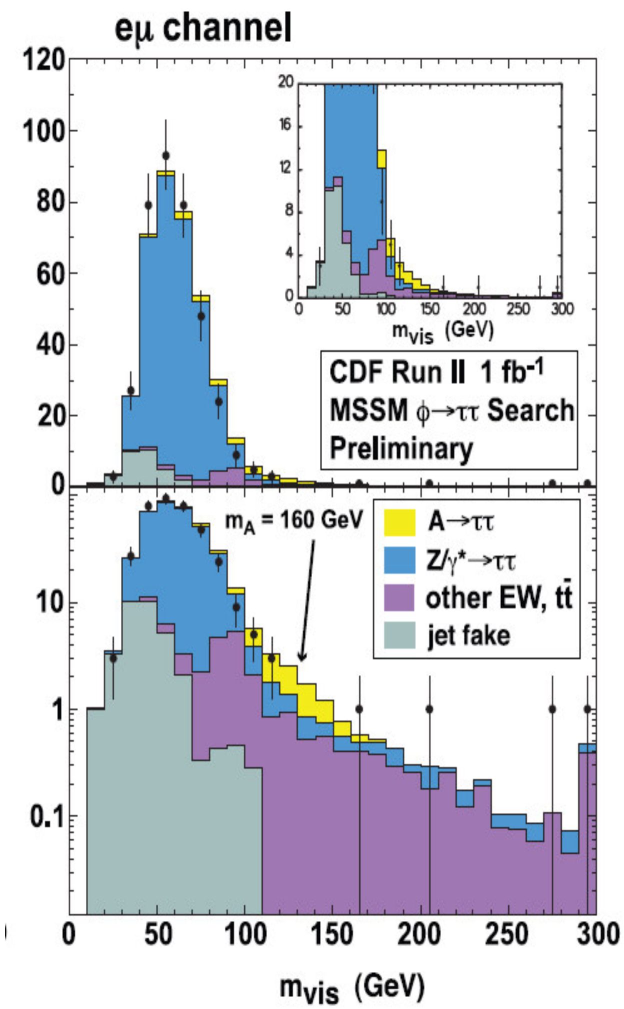


Eff(%)

Tau Type	1	2	3
Reconstruction			
Jets	1.5	10	38
Taus	9.1	50	20
NN > 0.9			
Jets	0.04	0.2	0.8
Taus	5.8	37	13

- Validated via Z's

CDF - MSSM Higgs $\rightarrow \tau_l \tau_{had}$



No excess seen in this channel

MSSM evolution